

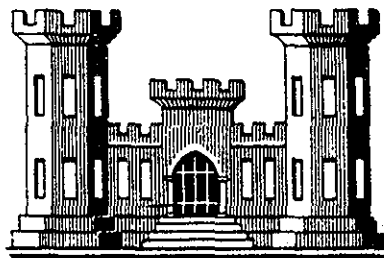
HOUSATONIC RIVER FLOOD CONTROL

BLACK ROCK DAM & RESERVOIR

Z BRANCH BROOK, CONNECTICUT

DESIGN MEMORANDUM NO. 5

GENERAL DESIGN



U.S. Army Engineer Division, New England
Corps of Engineers Waltham, Mass.

JANUARY 1965

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14. ABSTRACT This memorandum furnishes information and presents the general plan for the Black Rock flood control dam and reservoir project. It is intended to facilitate the preparation and review of detailed design memoranda, plans and specifications. This memorandum presents general data for the entire project, including costs and benefits. The data contained herein will be supplemented and expanded, as required, by supplement to this memorandum and by subsequent design memoranda.					
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U. S. ARMY ENGINEER DIVISION, NEW ENGLAND

CORPS OF ENGINEERS

**424 TRAPELO ROAD
WALTHAM, MASS. 02154**

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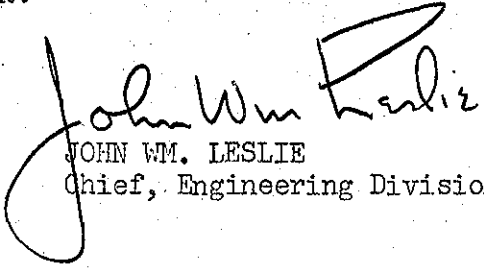
SUBJECT: Black Rock Dam and Reservoir - Branch Brook - Housatonic
River Basin, Connecticut - Design Memorandum No. 5 -
General Design

TO: Chief of Engineers
ATTN: ENGCW-E
Department of the Army
Washington, D. C. 20315

In accordance with EM 1110-2-1150, there is submitted
for review and approval Design Memorandum No. 5 - General Design,
for the Black Rock Dam and Reservoir - Branch Brook - Housatonic
River Basin, Connecticut.

FOR THE DIVISION ENGINEER:

Incl (10 cys)
Des Memo No. 5


JOHN WM. LESLIE
Chief, Engineering Division

U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
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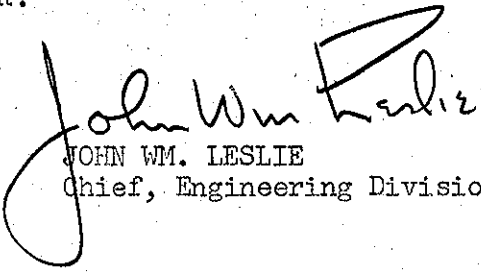
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Chief, Engineering Division

FLOOD CONTROL PROJECT
BLACK ROCK DAM AND RESERVOIR

BRANCH BROOK

HOUSATONIC RIVER BASIN
CONNECTICUT

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1	Hydrology	15 Jun 1964	23 Jul 1964
2	Site Geology	27 Aug 1964	24 Sep 1964
3	Real Estate		
4	Relocations		
5	General Design	29 Jan 1965	
6	Concrete Materials	31 Jan 1964	19 Feb 1964
7	Embankments and Foundations		
8	Detailed Design of Structures		
9	Preliminary Master Plan	2 Jul 1964	
10	Hydraulic Analysis		

BLACK ROCK DAM AND RESERVOIR

BRANCH BROOK

HOUSATONIC RIVER BASIN
CONNECTICUT

DESIGN MEMORANDUM NO. 5

GENERAL DESIGN MEMORANDUM

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LIST OF EXHIBITS

<u>Exhibit No.</u>	
1	Letter, Federal Power Commission, dated 24 May 1963
2-1-2-11	Letter, U.S. Fish and Wildlife Service, dated 1 April 1964 and Report, dated 25 April 1960
3	Letter, State of Connecticut Water Resources Commission, dated 3 September 1963
4	Letter, State of Connecticut Water Resources Commission, dated 24 April 1964
5	Letter, Bureau of Public Roads, dated 7 May 1963

BLACK ROCK DAM AND RESERVOIR
BRANCH BROOK
HOUSATONIC RIVER BASIN
CONNECTICUT

A. PERTINENT DATA

1. Purpose Flood Control

2. Location of Dam

State	Connecticut
County	Litchfield
Towns	Thomaston and Watertown
River	Branch Brook

Distance above:

Confluence Branch Brook and Naugatuck River	2.0 miles
Confluence Naugatuck and Housatonic Rivers	29 miles
Waterbury, Connecticut	8 air miles, south
Hartford, Connecticut	23 air miles, southeast
New Haven, Connecticut	26 air miles, southeast

3. Drainage Areas

Branch Brook at Damsite	20.4 square miles
Branch Brook at Mouth, con- fluence with Naugatuck River	23.0 square miles
Naugatuck River at Mouth, confluence with Housa- tonic River	312 square miles

4. Stream Flow

Record of U. S. G. S. Gaging Station on Leadmine Brook near
Thomaston, (Drainage Area = 24.0 square miles) October 1931
to September 1959.

<u>Time</u>	<u>c.f.s.</u>	<u>c.f.s./square mile</u>
Average Annual (28 years)	48.6	2.03
Maximum Year (1956)	73.0	3.04
Minimum Year (1932)	24.2	1.01
Maximum Month (Mar. 1936)	268	11.17
Minimum Month (Aug. 1949)	0.7	0.03
Maximum Day (19 Aug 1955)	3,660.	152.50
Minimum Day (26 Jun 1949)	0.1	0.004

5. Maximum Floods of Record

Record of U. S. G. S. Gaging Station on Leadmine Brook near Thomaston, Connecticut.

<u>Time</u>	<u>c.f.s.</u>	<u>Peak Discharge</u>
		<u>c.f.s./square mile</u>
August 1955	10,400	433
December 1948	5,150	214
October 1955	3,100	129
September 1936	3,050	127

6. Criteria for Spillway Design Flood

Peak inflow, full reservoir, cfs	35,000
Total volume of rainfall, inches	22.0
Infiltration rate, inches per hour	0.05
Total volume of runoff, acre-feet	22,600
Total volume of runoff, inches	20.8
Duration of storm, hours	24
Reservoir stage at start of flood, ft.,msl	520.0
Gates	Closed

7. Reservoir Elevations, Areas and Capacities

<u>Location</u>	<u>Elevations</u> <u>Ft.,msl.</u>	<u>Area</u> <u>Acres</u>	<u>Acre</u> <u>Feet</u>	<u>Inches On</u> <u>Drainage Area</u>
Permanent Pool	435	21	270	0.25
Spillway Crest	520	190	8,700	8.0
Flood Control Storage	435-520	190	8,430	7.75
Maximum Surcharge	535	227	11,800	10.8

8. Dam and Appurtenant Structures

a. Dam

Type	Rollled earth fill with rock slope protection
Top Elevation	540.0
Top Width, Feet	25.
Maximum Base Width, Feet	935.
Maximum Height, Feet	154.
Length, Feet	933.
Slope, upstream above Elevation 500	1 on 3
Slope, upstream between Elevation 500 and 470	1 on 5.5

8. Dam and Appurtenant Structures

a. Dam (Cont'd)

Slope, upstream between Elevation 470 and berm	1 on 2
Berm at Elevation 450.0	
Slope, upstream below berm	1 on 2
Slope, downstream to Elevation 500	1 on 2.5
Slope, downstream below Elevation 500	1 on 4
Freeboard above spillway design flood, height, feet	5

b. Spillway

Type	Uncontrolled, concrete overflow, chute channel in rock
Crest Length, Feet	140
Crest Elevation, Feet, msl	520
Maximum Head, Feet	15
Spillway design discharge, cfs	33,500

c. Outlet Works

Type	Upstream intake tower - dry-well type and rein- forced concrete square shaped cut-and-cover conduit
Size of Conduit	4'-0" x 5'-0"
Length of conduit, portal to portal, feet	704
Weir for permanent pool with stoplogs, operating eleva- tions, feet, msl	433 to 437
Conduit invert elevation, feet, m.s.l.	410
Number of Gates	2
Size of Gates	3'-0" x 4'-0"
Type of Gates	Hydraulic sluice
Elevation gate sill, feet, m.s.l.	410

Capacity discharge of outlet, reservoir at spillway crest, c.f.s. =	<u>1 Gate</u>	<u>2 Gates</u>
--	---------------	----------------

680

850

9. Real Estate

a. Fee Acquisition

(1) Land

<u>Classification</u>	<u>Area, Acres</u>
Commercial	3
Residential	47
Developable	68
Park Land	53
Woodland	257
Roads	<u>20</u>
Total Land	448

(2) Improvements

<u>Classification</u>	<u>Units</u>
Residences	21
Commercial	1
Gun Club Building	<u>1</u>
Total Improvements	23

10. Relocations

<u>a. Roads</u>	<u>Existing Mileage</u>	<u>Proposed Mileage</u>
Highways	2.1	1.9
<u>b. Utilities</u>		
Electric Distribution Lines	1.2 (Est.)	0.8 (Est.)
Electric Transmission Lines	0.3 (Est.)	0.3 (Est.)
Telephone Exchange Lines	2.3 (Est.)	1.4 (Est.)
Water Supply Line	1.9 (Est.)	1.7 (Est.)

11. Principal Quantities

Common Excavation, General	120,000 c.y.
Common Excavation, Borrow	1,000,000 c.y.
Rock Excavation, Open Cut	140,000 c.y.
Rolled Earth Embankment	940,000 c.y.
Gravel Bedding and Gravel Fill	152,000 c.y.

11. Principal Quantities (Cont'd)

Rockfill and Rock Slope Protection	140,000 c.y.
Concrete	7,000 c.y.
Cement	11,000 bbl.
Steel Reinforcement	625,000 lbs.

12. Estimated Project Cost (1964 Price Level)

Lands and Damages	\$ 538,000
Relocations	2,083,000
Reservoir	12,000
Dam and Appurtenant Structures	2,910,000
Buildings, Grounds and Utilities	44,000
Permanent Operating Equipment	13,000
Engineering and Design	500,000
Supervision and Administration	<u>340,000</u>

TOTAL ESTIMATED PROJECT COST	\$6,440,000
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FLOOD CONTROL PROJECT
BLACK ROCK DAM AND RESERVOIR

BRANCH BROOK

HOUSATONIC RIVER BASIN
CONNECTICUT

DESIGN MEMORANDUM NO. 5

GENERAL DESIGN

JANUARY 1965

B. INTRODUCTION

1. Purpose. - This memorandum furnishes information and presents the general plan for the Black Rock flood control dam and reservoir project. It is intended to facilitate the preparation and review of detailed design memoranda, plans and specifications.

2. Scope. - This memorandum presents general data for the entire project, including costs and benefits. The data contained herein will be supplemented and expanded, as required, by supplement to this memorandum and by subsequent design memoranda.

C. PROJECT AUTHORIZATION

3. Authorization. - The Black Rock Project was authorized by the Flood Control Act approved 14 July 1960, Public Law 86-645, which reads in part as follows:

"The project for the flood control dams and reservoirs on the Naugatuck River, Connecticut, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 372, Eighty-sixth Congress, at an estimated cost of \$10,230,000."

4. Chief of Engineers Recommendations. - In House Document No. 372, 86th Congress, 2nd Session, the Chief of Engineers recommended "... the improvement of Naugatuck River by the construction of four reservoirs for flood control on Northfield Brook, Branch Brook, Hancock Brook, and Hop Brook, at an estimated cost, all Federal, of \$10,230,000 for construction and \$30,000 annually for maintenance and

operation. The work would be subject only to the requirement that local interests give assurances that they will establish encroachment lines downstream of the recommended dams to permit reasonable, efficient reservoir operation."

D. INVESTIGATIONS

5. Latest Interim Report. - The interim report on review of survey for flood control, Housatonic River Basin, Naugatuck River, Connecticut, dated 30 June 1958, contains the report on the Black Rock Dam and Reservoir. The report was published without appendices, except letters of comment, in House Document No. 372, 86th Congress, 2nd Session. The preparation of the report was authorized by resolution of the Committee on Public Works of the United States Senate on 14 September 1955 and the House of Representatives on 13 June 1956. The report recommended that the authorized plan for flood control in the Housatonic River Basin be modified to provide for construction of flood control dams and reservoirs on Northfield Brook, Branch Brook, Hancock Brook, and Hop Brook. Further, the report provided for construction of a flood control reservoir, on Branch Brook, of 8,860 acre-feet capacity equivalent to 8.0 inches of runoff from its net drainage area of 20.8 square miles. The site is in the Towns of Watertown and Thomaston about 2.0 miles upstream from the confluence of Branch Brook and Naugatuck River.

6. Prior Reports. - Flood control in the Naugatuck River and its tributaries has been considered in the following published reports on the Housatonic River.

a. "308" Report. - A report, dated 25 June 1931, and printed as House Document No. 246, 72nd Congress, 1st Session, included navigation, water power, flood control and irrigation in the Housatonic River Basin. The report found that further improvements were not warranted at that time.

b. 1940 Report. - A report, dated 20 June 1940, and printed as House Document No. 338, 77th Congress, 1st Session, recommended construction of the Thomaston Dam on the Naugatuck River above Thomaston, Connecticut. This project was authorized by Public Law 534, 78th Congress, 2nd Session, approved 22 December 1944.

c. 1956 Report. - An interim report, dated 31 May 1956, and printed as House Document No. 81, 85th Congress, 1st Session, covered flood control on the Upper Naugatuck River above Torrington, Connecticut, and recommended the construction of Hall Meadow Brook Reservoir and the East Branch Reservoir. These projects were authorized by Public Law 500, 85th Congress, approved 3 July 1958.

7. Reports of Other Agencies. -

a. NENYIAC Report. - Flood control and allied water uses are also considered in Part 2, Chapter XXII, "Housatonic River Basin" of "The Resources of the New England-New York Region". This comprehensive report inventoried the resources of the New England-New York area and recommended a master plan to be used as a guide for the regional planning, development, conservation, and use of land, water, and related resources of the region. Also included were proposals to reduce flood losses. Prepared by the New England-New York Interagency Committee, the report was submitted to the President of the United States by the Secretary of the Army on 27 April 1956. Part I and Chapter I of Part 2 are printed as Senate Document 14, 85th Congress, 1st Session.

b. Naugatuck Valley River Control Commission. - The Naugatuck Valley River Control Commission has issued an Interim Report on the problems of flood control on the Naugatuck River and tributaries dated March 1956. Various other reports have also been prepared by Town and State agencies.

8. Current Investigations. - Studies for the project plan utilized the basic data obtained for the previous investigations. In addition, the following new data were obtained and studies made:

a. New photogrammetric maps of the reservoir area were made and new area-capacity curves computed. A new large scale topographic survey map of the dam site was prepared.

b. All available subsurface information has been reviewed and the geological and soils investigations of foundation conditions and embankments materials are being completed.

c. Hydrologic studies have been reviewed and new studies have been made to determine the reservoir capacity, the spillway design flood and outlet requirements. The Design Memorandum on Hydrology was prepared and submitted to the Chief of Engineers on 15 June 1964 and approved 23 July 1964.

d. New preliminary appraisals of lands and damages to improvements in the reservoir, work and borrow areas have been completed and are reported in Section O of this Memorandum.

e. Relocation of roads within the reservoir has been discussed with State and Town officials. Preliminary studies of the affected roads have been made.

f. Relocations of utilities have been discussed with the owners and preliminary studies have been prepared.

9. Coordination with Other Federal and Non-Federal Agencies. -

a. Federal Power Commission. - During the preparation of the interim report of June 1958, the Federal Power Commission reviewed the power potentialities of the Black Rock Dam and concluded that the multiple-purpose development of the Black Rock site for power and flood control was not economically feasible. The views of the Federal Power Commission were confirmed in letter dated 24 May 1963 which is included as Exhibit No. 1 of this Memorandum.

b. U. S. Department of Health, Education and Welfare. - The U. S. Department of Health, Education and Welfare has informally presented their views that they do not envision any major vector problems will be created by the construction of the Black Rock Reservoir. A complete report, being prepared by the U. S. Health, Education and Welfare, will be transmitted to the Office of the Chief of Engineers as soon as it becomes available.

c. U. S. Fish and Wildlife Service. - The Chief, Division of Technical Services of the U. S. Fish and Wildlife Service, in letter dated 1 April 1964, Exhibit No. 2-1 of this Memorandum, indicates that the letter report from the Regional Director of the U. S. Fish and Wildlife Service, dated 25 April 1960, Exhibit No. 2-2 of this Memorandum, is still valid. The report is the result of an investigation of the effect of the project upon fish and wildlife resources of the area.

d. State of Connecticut, Board of Fisheries and Game. - The report on fish and wildlife of the Black Rock Reservoir, prepared by the U. S. Fish and Wildlife Service, was indorsed by Connecticut State Board of Fisheries and Game. See Exhibit No. 2-11 of this Memorandum.

e. State of Connecticut, Water Resources Commission. - The authorizing document for the Black Rock Dam and Reservoir requires that construction be contingent upon the zoning of the river channel downstream of the dam. In the letter of 3 September 1963, the Director, State of Connecticut Water Resources Commission, advises that zoning will be completed before the dam is completed. See Exhibit No. 3 of this Memorandum. The Director also states in letter dated 24 April 1964 that there is presently no interest in the addition of water supply storage in the Black Rock Reservoir. See Exhibit No. 4 of this Memorandum.

f. U. S. Department of Commerce, Bureau of Public Roads. - In accordance with the provisions of Public Law 562, the Bureau of Public Roads was requested to ascertain whether the proposed Black Rock Dam was needed or desired to serve as a public highway bridge. In letter dated 7 May 1963, the Bureau advised that no public highway bridge is economically desirable or needed on this dam at this time. Letter dated 7 May 1963 is included as Exhibit No. 5 of this Memorandum.

10. Public Hearings. - A public hearing was held on 11 December 1956 in Waterbury, Connecticut, to determine the need for additional projects for flood control and allied purposes on the Naugatuck River, Housatonic River Basin, Connecticut. Improvements requested by the Naugatuck Valley River Control Commission and representatives of Federal, State and municipal governments included flood control dams and reservoirs and various local improvements.

E. LOCAL COOPERATION

11. Local Cooperation. - The Act which authorizes the Black Rock Flood Control Project does not require local cooperation in connection with its construction. All construction costs of the project will be met with funds of the United States. Local cooperation is, however, required to the extent that the channel through the downstream damage areas be zoned to prevent further encroachment and to prevent the replacement of obstructive or hazardous structures along the channel whenever they become obsolete. The State of Connecticut has established such encroachment lines on the main stem of the Naugatuck River. In letter dated 3 September 1963, the Director, State of Connecticut Water Resources Commission, assured that these lines would be completed before or close to the time that the construction of the project is completed.

F. LOCATION OF PROJECT AND TRIBUTARY AREA

12. Location of Project. - The Black Rock Reservoir Project is located in the Towns of Thomaston and Watertown, Connecticut. The dam site is located on the Branch Brook about 2.0 miles above its confluence with the Naugatuck River. The reservoir will extend upstream along the Branch Brook about 1.8 miles. The total drainage area of the Branch Brook is 23 square miles and the drainage area at the dam site is 20.4 square miles. See Basin Map, Plate No. 5-2 and Reservoir Map, Plate No. 5-3.

13. Description of the Naugatuck River Basin. - The Naugatuck River, principal tributary of the Housatonic, is a rapidly flowing, non-navigable stream. The watershed, which lies wholly within the western part of Connecticut, is about 50 miles long with a maximum width of 12 miles and a total drainage area of 312 square miles. The drainage area at Torrington is about 50 square miles. The headwaters of the Naugatuck lie about 6 miles south of the Massachusetts line in the southeast corner of the Town of Norfolk at an elevation of about 1,500 feet. Between the headwaters and Torrington, the river falls approximately 900 feet in about 13 miles. The general direction of flow is southerly, thru Torrington, Thomaston, Waterbury, Naugatuck, Beacon Falls, Seymour, and Ansonia to Derby, where the Naugatuck joins the Housatonic in its tidal reach about 12.25 miles from Long Island Sound.

The Naugatuck River is formed in the City of Torrington by the confluence of its West and East Branches. The river is fed by relatively small steeply falling brooks. The other principal tributaries are Leadmine Brook, Branch Brook, Steel Brook, Hancock Brook, and Little River. See Naugatuck River Watershed, Plate No. 5-1.

G. RECOMMENDED PROJECT PLAN

14. Recommended Project Plan. - The recommended project plan provides for an earth and rock fill dam 933 feet long and 154 feet in height above stream bed. A chute spillway with a 140-foot crest length concrete weir will be located adjacent to the right abutment of the dam. The outlet works will consist of a 4-foot by 5-foot cut-and-cover concrete conduit founded on rock is the right abutment of the dam.

The Connecticut State Route 109, a bituminous surface State road on the left bank of the river valley in the reservoir, will require relocating and raising above the guide-taking line, a total of about 1.9 miles. Northfield Road will normally be abandoned. Old Morris Road will be raised above the guide-taking line for a short distance.

Electric and telephone lines will be relocated along the relocated road.

One structure in the overhead transmission line will be relocated to avoid the new spillway discharge channel.

The existing 36-inch water supply line and appurtenant structures of the City of Waterbury will be relocated out of the reservoir area.

The structures, improvements and relocations are described in detail in Section I, Description of Proposed Structures and Improvements. The various structures and topography at the site, and proposed alignments of road relocations are shown on Plate Nos. 5-3 and 5-4.

H. DEPARTURE FROM PROJECT DOCUMENT PLAN

15. Project Document Plan. - The Black Rock Project was authorized under the Flood Control Act of 14 July 1960 in general accordance with the plan presented in House Document No. 372, 86th Congress, 2nd Session. This plan proposed flood control storage of 8,860 acre-feet, equivalent to 8.0 inches of runoff from the tributary drainage area of 20.8 square miles. From the available

U.S.G.S. quadrangle sheets, this capacity set the spillway crest elevation at 513 feet, mean sea level.

16. Departure from Project Document Plan. - The following modifications and changes from the approved document plan have been made during the development of detailed studies based on additional investigations and information obtained.

a. The area-capacity curves developed from the new photogrammetric maps of the reservoir indicated that to obtain the authorized storage of 8 inches, the spillway crest elevation would have to be at elevation 515.0 feet, mean sea level, at the survey report site and elevation 520.0 feet, mean sea level, at the recommended site. See Area-Capacity Curves, Plate No. 5-10.

b. The dam site has been shifted approximately 600 feet upstream from the project document site to better utilize existing topography, obtain better rock foundation, and to obtain a more equitable balance of material for the relocated road and to avoid extensive relocation of the existing 2-69 kv transmission lines.

c. The top elevation of the dam has been raised from elevation 533.0 to 540.0 mean sea level due to the shifting of the dam upstream, the new area-capacity curves, and the spillway modification described below.

d. Results of economic studies based on a 170-foot side channel spillway with a 15-foot surcharge on the left abutment versus a 140-foot chute spillway with a 15-foot surcharge on the right abutment indicated that the chute spillway should be adopted.

e. Results of embankment design have indicated that the upstream and downstream slopes of the dam would have to be flattened. The embankment has been modified to fully utilize all available materials from required excavations and from nearby available borrow areas.

f. An access berm has been added on the upstream face of the dam to permit passage of wheeled vehicles to the intake structure for maintenance and debris clearing operations.

g. The conduit has been changed from a 4-foot 6-inch diameter reinforced concrete pipe encased in concrete founded on rock to a 4'-0" by 5'-0" rectangular cast-in-place reinforced concrete section founded on rock.

h. The highway relocation plan has been revised to avoid taking five (5) residences and reducing the length of relocated highway by 0.4 mile. The revised alignment passes the left abutment and with the relocation of the spillway to the right abutment, this eliminates the need of the dam site access road shown on the document plan.

i. The 36-inch water supply aqueduct and appurtenant facilities within the reservoir of the City of Waterbury will be relocated outside of the Black Rock Reservoir area, from the existing Wigwam Reservoir to a point downstream of the proposed dam. Under its present location, the aqueduct would pass under the dam and be submerged by the permanent pool.

I. HYDROLOGY

17. Spillway Design Flood. - The spillway design flood was computed by applying rainfall excess resulting from probable maximum precipitation reduced as recommended in letter File No. ENGCEW-EY, Subject, "Hop Brook Dam and Reservoir, Hop Brook, Housatonic River Basin, Connecticut, Design Memorandum No. 1 - Hydrology", dated 10 April 1964, to the adopted two-hour unit hydrograph. The total rainfall amounted to 22.0 inches in 24 hours with 18.0 inches occurring in the maximum six-hour period. Losses were assumed to a rate of 0.05 inches per hour, resulting in rainfall excess of 20.8 inches. The flood hydrograph with a peak inflow of 35,000 c.f.s. was routed through the reservoir storage assuming the reservoir filled to spillway crest and the outlet inoperative. For the tentatively selected spillway length of 140 feet, the spillway outflow would be 33,500 c.f.s. and the surcharge 15.0 feet.

18. Channel Capacity. - The channel capacity of Branch Brook downstream of the dam is estimated to be 600 c.f.s.

19. Flood Control Outlet. - The selected outlet for Black Rock will consist of a 4' x 5' conduit and two 3' x 4' gates. With the reservoir about 15 percent full, the discharge through the conduit will be about 600 c.f.s. The capacity will allow emptying of the reservoir from full pool in about 8 days and also will satisfy diversion requirements.

20. Freeboard. - A freeboard of 5.0 feet above the maximum surcharge pool elevation of 535.0 is provided resulting in a top elevation of dam of 540.0 feet, mean sea level.

21. Reservoir Capacity. - Prior to 1955, it was considered that there should be sufficient storage capacity in a flood control reservoir to hold 6 inches of run-off from the watershed upstream of the project. Following the major floods of 1955, a reappraisal was made

of storage requirements in flood control reservoirs in New England. In general, the volume of run-off experienced in the 1955 floods had demonstrated that it is desirable to provide at least 8 inches whenever feasible. On this basis, the Black Rock Project was recommended for authorization as an 8-inch flood control reservoir. In addition, a small permanent pool of 0.25 inches will be provided for recreational purposes.

J. GEOLOGY

22. General. - Branch Brook, upon which Black Rock Dam will be located, flows through the Connecticut Highlands, a rugged, maturely dissected upland of moderate relief, underlain by crystalline rocks. The upland surface is characterized by rough, irregular, southeasterly trending ridges, standing generally at an elevation of about 1000 feet, and relatively deep, steep-sided valleys. The topography, which has been modified by glaciation, is controlled largely by the underlying, complexly folded and much altered schists, gneisses and granites which are extensively exposed on many of the valley walls and ridges. The bottoms of the valleys are occupied by thick deposits of glacial till and outwash sands and gravels, upon which many of the present streams are superimposed. In some places, the streams, in their meandering and downcutting, have exposed bedrock spurs low on the sides of ancient valleys. Above the outwash, the slopes and tops of the ridges are mantled with glacial till.

23. Site Geology. - In the site area, Branch Brook is flowing in a narrow, rock-controlled valley, the slopes of which rise sharply from a small valley flat. The general surface configuration and rock outcrop distribution in the site area, and subsurface conditions along the project centerline, are shown on a plan of foundation explorations and a geologic log-section, Plate Nos. 5-9 and 5-10, respectively. The right or south abutment is blanketed by up to 15 feet of glacial till through which bedrock outcrops extensively along the toe of the abutment and on the upper slopes downstream of the project centerline. Scattered outcrops occur elsewhere on the abutment. Bedrock outcrops extensively throughout most of the left abutment particularly downstream of the project centerline where it is exposed in a series of near vertical cliffs from river level to the top of the abutment. Nominal amounts of till and till-like materials mantle the rock surface between the outcrops, and occur to depths of 10 feet in a broad trough in the upstream half of the abutment. The valley bottom is occupied by extensive deposits of glacial outwash and more recent alluvial, sands and gravels. These materials vary in thickness from over 75 feet in the broad depression at the downstream toe of the embankment, to 10 - 15 feet at the centerline where they are overlain in part by some 10 feet of highway fill. It

will be feasible, therefore, to construct a cut-off to bedrock across the entire site, either at the project centerline or just upstream.

24. Bedrock Characteristics. - The bedrock consists principally of quartz-mica schist which has been much injected with medium to coarse-grained (pegmatitic) granite. The rock is closely jointed, particularly the top 10-15 feet, which zone is also variably weathered, below this zone the rock is generally hard and fresh. Some evidence of fault activity is apparent in the area of the broad depression in the valley floor and in the lower left abutment. Foliation, which trends approximately north-south or roughly normal to the river and dips at 40-50 degrees west or upstream, is generally well developed. Outlet works and spillway channel alignments are roughly normal to the trend of the bedrock structure, which relationship will aid in the control of overbreak and in obtaining stable slopes.

Water losses recorded during hydraulic pressure testing of some of the borings, though generally small, coupled with the closely jointed and fractured condition of the upper zone of rock, which in some instances prevented pressure testing, indicates a need for some grouting for control of seepage. More detailed discussion of the geology conditions has been presented in Design Memorandum No. 2 - Site Geology, submitted to the Chief of Engineers on 27 August 1964 and approved 24 September 1964. Detailed discussion of the foundation conditions will be presented in Design Memorandum No. 7 - Embankments and Foundations.

K. OTHER PLANS INVESTIGATED

25. Other Sites Investigated. - During the preauthorization studies, a potential dam site about 1.1 miles downstream from the Black Rock site was investigated. Both sites were included in the Interim Report on Review of Survey, Naugatuck River, and are alternates to each other. However, being the more economical in overall project cost, the Black Rock Dam was selected and authorized by Congress.

26. Other Layout Plans at the Black Rock Site. - Various alignments of the dam and a side channel spillway were studied in detail. The selected alignment of the dam is predicated on the shifting of dam approximately 600 feet upstream from the recommended site to more suitable foundation conditions. Such a shift when combined with reducing the length of the relocated Route No. 109 permits access to the top of dam from the left abutment thereby eliminating the proposed access road on the right abutment. In so doing, and in order that a bridge over the spillway be avoided, the

spillway was relocated to the right abutment and was changed from a side channel spillway to a chute spillway which was more suited for the topography in that area.

A study was made for a concrete dam at the recommended site instead of a rock and earth fill dam. The study was made to determine the most economical and feasible structure. The layout for the concrete dam studied is shown on Plate No. 5-13. The detailed cost estimate for the concrete dam indicates that the concrete dam could not compete economically with the rock and earth fill dam, the concrete dam being \$790,000 more than the rock and earth fill dam. Therefore, the concrete dam was eliminated from further consideration at this site.

I. DESCRIPTION OF PROPOSED STRUCTURES AND IMPROVEMENTS

27. General. - A description of each of the principal elements of the proposed plan of improvement for the Black Rock Reservoir Project is presented in the following paragraphs. Studies to develop design details for each element are under way and will be presented in subsequent Design Memoranda.

154 28. Dam. - The project plan provides for the construction of a rolled earth fill dam with upstream and downstream rock slope protection approximately 938 feet long with a maximum height of 933 feet about 155 feet above the stream bed. The top width of the dam will be 25 feet with an 18-foot wide paved roadway. Access to the top of the dam will be by an access road from the relocated road on the left abutment. The top elevation of the dam will be 540.0 feet, mean sea level, providing 15.0 feet of spillway surcharge and 5.0 feet of freeboard. The alignment of the dam is curved to position the dam where advantage could be taken of the rock abutments, thereby keeping the length of dam at a minimum.

The dam embankment design is influenced by the foundation conditions and the availability and characteristics of embankment materials. Required earth excavations for the project will furnish a relatively small portion of the earth embankment materials needed for the dam. The bulk of these embankment materials will be obtained from a borrow area in a glacial till deposit located upstream and above the right abutment of the dam. The outside embankment slopes have been tentatively established on the basis of preliminary stability studies. The embankment section will be of the zoned type and will consist of zones of impervious, random and pervious embankment materials and rock fill. The locations, composition and dimensions of the zones will be established on the basis of the relative availability and characteristics of the various types of materials as determined by investigations now in progress. The embankment slopes, above the

rock fill toes, both upstream and downstream, will be protected by layers of rock and appropriate bedding materials. The embankment section will include an impervious foundation cut-off, a continuous grout curtain in the bedrock, a downstream drainage blanket and similar features as required for the adequate control of seepage through the foundation and seepage through the embankment. For embankment plan, profile of the dam and a tentative embankment section, see Plates No. 5-4 and 5-5.

29. Spillway. - The spillway will be chute type, located in a rock cut on the right bank. For details see Plate Nos. 5-4 and 5-6. The weir will be a low concrete ogee section founded on bedrock. The length of the weir will be 140 feet at spillway crest elevation 520.0 feet, mean sea level. The height of the concrete weir above the spillway approach will be 8 feet, making the maximum elevation of the approach channel 512.0 feet, mean sea level, at the upstream face of the spillway weir. The excavated approach channel will slope down into the reservoir at a 1.0 percent grade for drainage. The spillway chute or discharge channel excavated in earth and rock will be about 535 feet. It will slope down from an invert elevation 512.0 at the weir to invert elevation 504.3 in 154 feet, and thence to invert elevation 456.3 in 120 feet at which point it will flow on a 2.0 percent grade for a distance of about 260 feet toward the brook. The discharge channel width will vary from 140 feet near the weir to 40 feet in a distance of 295 feet. The 40-foot channel width will be maintained for the remaining distance of 200 feet. The total length of the excavated channel will be about 855 feet and the bottom slope will vary from a minimum of 1.0 percent to a maximum of 40.0 percent. Excavated materials from the spillway will be used in the dam embankment to the greatest extent possible.

30. Outlet Works. - The outlet works will be located on the right bank under the dam and will consist of intake channel, an intake tower, a conduit on rock under the dam and an outlet channel. Details of the outlet works are shown on Plate No. 5-7.

a. Intake Channel. - The 14-foot wide and 152-foot long intake channel will be excavated partly in rock, with bottom elevation at 410 feet, mean sea level. The channel immediately upstream of the tower will contain trash bars, a concrete platform at elevation 450 feet, mean sea level, and a stoplog control storage weir, discharging into the gated conduit with a maximum crest elevation of 437, mean sea level. The six stoplog openings of the control weir will be 4 feet deep for flexibility in operation of the permanent pool. To control trash, a log boom will be provided.

b. Intake Tower and Operating House. - The intake tower will be located 330 feet upstream of the centerline of the dam and will be a dry well type structure about 160 feet in height, including the 25-foot high operating house, and will be provided with a service bridge for access. Lightning arresters will be provided for the tower and operating house. The lower part of the structure will contain the gate chamber and two 3-foot wide by 4-foot high rectangular entrance conduits at invert elevation 410 feet, mean sea level, controlled by vertical service slide gates. There will be no emergency gates; however, a stoplog structure will be provided. The gates will be operated by a central high-pressure oil system. The pier will be extended upstream to support a platform at elevation 450 feet, mean sea level, and the stoplog slots. Access will be provided along the 15-foot wide berm at the dam.

The intake tower will contain three floors: (1) the heater room floor (elevation 529.22), (2) operating floor (elevation 541.0), and (3) the equipment room floor (elevation 554.0). The operating tower will house the high pressure oil hydraulic system for operation of the gates, a continuous waterstage recorder, an electrical switchboard, an emergency diesel engine generator and a high-lift crane. The heater room floor will contain a forced warm air heating system and oil pump and motor standby unit. The gate chamber at elevation 418.5 will contain two individual hydraulically operated service slide gates, and a sump pump located in a well. An elevator will be provided for travel from the operating floor to elevation 318.0. Electric power will normally be obtained from commercial sources.

The two 3-foot wide by 4-foot high entrance conduits under the intake tower will extend on parallel axis 8 feet apart thru the tower to a point approximately 13 feet downstream from the centerline of the service gates. At this point, the alignment of the two conduits will be turned to converge toward the center of the single conduit. The dividing wall will terminate 39.5 feet downstream of the centerline of the gates. The section at the end of the dividing wall will be rectangular and will gradually be warped to a 4-foot by 5-foot high rectangular shaped conduit in a distance of approximately 40 feet.

c. Conduit. - The 4-foot wide by 5-foot high rectangular shaped conduit constructed on rock under the dam will have a total length (excluding transition) of approximately 712 feet with its upstream invert at elevation 410 feet, mean sea level. The conduit will slope about 1.9 percent for a distance of 712 feet beyond the transition to the portal outlet at elevation 396 feet, mean sea level. The conduit will be reinforced concrete. Seep collars will be provided if required.

d. Outlet Channel. - The outlet channel, excavated in earth and rock, will be 14 feet wide and approximately 126 feet long, having a 20 percent slope, for 25 feet, from elevation 396.0 to elevation 391.0, then a 3 percent slope for 53 feet from elevation 391.0 to elevation 388.0, and thence at a level grade for a distance of about 48 feet toward the brook. The sides and the bottom of the outlet channel will be lined with concrete for a distance of 25 feet from the outlet portal. A stilling basin is not considered necessary.

31. Reservoir Clearing. - The portion of the reservoir below elevation 438 feet, mean sea level, which is 3 feet above the top elevation of the permanent pool (elevation 435) will be cleared. The area at this elevation is approximately 25 acres. Only about 16 acres of the land to be cleared are wooded.

32. Administrative Facilities and Utilities. - A combined utility building and garage, 24 feet by 40 feet, 6 inches, will be constructed downstream of the dam along the east side of existing Route No. 109. See Plate No. 5-4. The building will include office, toilet, heater room, workshop and garage facilities, and comfort station for public use.

33. Access Roads and Railroad Facilities. -

a. Access Roads. - The site is located on Connecticut State Route 109 which will be relocated. The relocated road will be adjacent to the north abutment of the dam and will serve as the main access road. Access to the reservoir and permanent pool area will be via existing roads within the project area.

b. Railroads. - Railroad transportation is available from Thomaston on the New York, New Haven and Hartford Railroad. The distance to the nearest unloading facilities is about 2.8 miles.

34. Use of Consultants. - The Black Rock Reservoir Project imposes no complex design problems. Technical specialists of the Office of the Chief of Engineers will be consulted and their services utilized in establishing the design criteria and the design and safety of the proposed structures and facilities.

M. SOURCES OF CONSTRUCTION MATERIALS

35. Materials for Earth Embankment Construction. - It is expected that materials from required excavation will be generally suitable for use in construction of the random sections of the embankment. Additional random, and impervious materials will be obtained from a borrow area located $\frac{1}{2}$ mile upstream.

Pervious materials will be obtained from commercial sources of which there are at least four within 15 miles of the project.

36. Rock Slope Protection. - Much of the rock from required excavations will be closely jointed and highly fissile in nature. Use for slope protection, particularly on the upstream slope will require selection and possibly processing.

37. Concrete Aggregate. - Aggregate studies made for this and other projects in the vicinity, indicate the availability of both fine and coarse aggregate materials from eight approved, and one untested, commercial sources within a twenty-mile haul distance of the project. Results of tests performed on materials from the eight approved sources are listed in Design Memorandum No. 6, CONCRETE MATERIALS, BLACK ROCK DAM AND HOP BROOK DAM, dated 31 January 1964 and approved 19 February 1964.

N. RESERVOIR MANAGEMENT AND PUBLIC USE

38. Fish and Wildlife Resources. - The U. S. Fish and Wildlife Service, in cooperation with the Connecticut Board of Fisheries and Game, has prepared reports on the fish and wildlife aspects of four flood control reservoirs on tributaries of the Naugatuck River within the Housatonic River Basin. Black Rock Dam and Reservoir is located therein. The basic report, dated 25 April 1960, and a review report, dated 1 April 1964, are inclosed as Exhibits 2-1 and 2-2 of this memorandum.

Branch Brook is considered an excellent trout stream which is estimated to provide about 1,500 angler-days of recreation annually through a stocking program.

The greater part of the reservoir area is forested and provides good small game habitat. However, since about 50 percent of the reservoir area is within Black Rock State Park where hunting is not permitted, the small area open to hunting receives light pressure.

As a means of mitigating losses to the recreational and fish and wildlife resources which will result from the operation of the project, provision has been made for the inclusion of a conservation pool at elevation 435.0 feet, mean sea level, which has a surface area of about 21 acres and a maximum depth of about 35 feet. Control of pool level is affected by a stoplog structure.

The Board of Fisheries and Game of the State of Connecticut indicates it is prepared to undertake management activities under a suitable lease agreement.

More detailed discussion of the fish and wildlife program is contained in letter to the Chief of Engineers, dated 2 July 1964, ATTN: ENG CW-O, Subject: "Black Rock Dam and Reservoir, Housatonic River Basin, Connecticut - Preliminary Master Plan Studies."

39. Recreation. - About 50 percent of the Black Rock Reservoir including the dam and the 21-acre conservation pool will be located within Black Rock State Park. The developed state park centered around the 20-acre Black Rock Pond is located immediately downstream of the proposed damsite. The Connecticut State Park and Forest Commission desires no additional park type development of the Black Rock Reservoir at this time due to the nearness of the Black Rock State Park, which offers facilities for swimming, picnicking, fishing, hiking, sightseeing and camping, with adequate land and water areas set aside for future expansion. It is felt that the existing facilities available at the State Park are sufficient for present demands.

The reservoir is located in the populous west central area of Connecticut. The 1960 census showed a population of about 1.1 million people within a radius of 25 miles of the project and about 2.4 million within an hour's drive, or forty miles. The growth rate in this section of the state is about a 25 percent increase over the 1950 census.

The present plan for recreational use of Black Rock Reservoir contemplates that the Federal lands and included water areas would be made available for public use. Existing Route 109 and Northfield Road would be preserved for public access purposes. Facilities for high density activities would not be included at this time because of the proximity of other available resources. A 21-acre permanent conservation pool would be maintained at elevation 435 feet, mean sea level, to enhance fishing resources and aesthetic value of the reservoir. A Master Plan will be prepared for the project and lands will be allocated for future development to be undertaken when necessary.

The various agencies of the State of Connecticut are prepared to undertake management programs under suitable lease agreement to include recreation, fish and wildlife, forestry and other resources of the reservoir area. They have recommended that development be incorporated with the development at Black Rock State Park.

O. REAL ESTATE

40. General. - The acquisition of land for the Black Rock Dam and Reservoir will be made in accordance with the regulations set forth in EM 405-2-150, dated 1 October 1958, as amended, with changes, Real Estate Planning and Project Authorization, Civil Works Projects.

41. Area Description. - The Black Rock Reservoir is located in the Towns of Thomaston and Watertown, Connecticut. The proposed dam is to be located on Branch Brook about 2.0 miles above the confluence of Branch Brook and Naugatuck River.

The reservoir will be contained by two parallel ridges in a narrow elongated basin which extends upstream for a distance of approximately 1.5 miles. The upper reach is located at the toe of the existing Wigwam Reservoir, a part of the water supply of the City of Waterbury.

Approximately one-half of the acreage required for the project is owned by the State of Connecticut (Black Rock State Park) and the Water Commission of the City of Waterbury. The Black Rock State Park lies in the Towns of Thomaston and Watertown and contains about 464 acres. Nearly all of the improved picnicking, swimming, camping, fishing, and hiking areas are situated beyond the limits of the proposed guide taking lines. The exceptions are two areas located on both sides of Route No. 109 near the damsite. About 2 acres of land south of the highway has been improved by pruning and the construction of park roads and is used for picnicking purposes. Across the highway is an area which the State of Connecticut has leased to the Wigwam Gun Club. They have constructed a small club house and a series of firing ranges on the acreage. Possession of the land by the Gun Club is held under a license which is revocable upon 30 days by written notice. This license is not exclusive, and the public may enjoy the use of the area for all recreational activities which do not conflict with the purpose of the license. The land owned by the City of Waterbury is utilized by the Water Commission and contains an aqueduct, a chlorination building, a chemical building and a gate house. Throughout the reservoir area, are twenty-one family residences which are located along both Northfield Road, State Route No. 109, and Old Morris Road. Their values range from \$6,000 to \$25,000. An area located within the damsite is utilized as a combination home and retail second-hand commercial operation.

42. Land Requirements. - The minimum guide taking line for the Black Rock Dam and Reservoir Project has been established at 300 feet horizontally from the static full pool elevation (Spillway Crest 520.0 feet, mean sea level)

Fee simple title will be required for project operation including areas for construction, permanent structures, borrow, highway relocations and the reservoir. The actual property acquisition line cannot be accurately estimated at this time due to the lack of detailed property maps and inadequate tract data. On the basis of information available, the total area to be acquired in fee will approximate 448 acres.

Specific exceptions to the standard acquisition policy will be presented and approval requested with the submission of Design Memorandum No. 3, Real Estate, after further development of individual ownerships.

43. Relocations. - Current relocation plans indicate that sections of Route No. 109, the water supply aqueduct and appurtenant structures, and electric transmission and distribution lines and telephone cable and rural lines will be relocated within the project area. Therefore, no additional land requirements are included in this report. However, the real estate costs of those sections of the above required relocations which will be relocated outside of the project area will be included in the forthcoming Design Memorandum No. 4 - Relocations.

There are no structures or facilities in the project area which fall within the purview of Section III of the Act of Congress approved 3 July 1958 (Public Law 85-500).

44. Severance Damages. - Severance damages occur when partial takings are acquired. It is planned to follow good sound real estate acquisition practice so that damages will be minimized. At the present time, with only a general knowledge of individual property bounds, it is estimated that damages of this nature will approximate \$5,000.

45. Water Rights. - The preliminary survey of the proposed taking area failed to disclose any water rights other than those held by the City of Waterbury for their water supply system. The City of Waterbury has a water supply dam and reservoir immediately upstream of the upper limits of the proposed taking line.

46. Mineral and Crop Damages. - The instance of special value attributed to mineral deposits or growing crops has been noted.

47. Valuations. -

a. Land. -

Commercial & Residential	50 Acres	@ \$2,500	= \$125,000
Developable	68 "	@ 700	= 47,600
Park Land	53 "	@ 500	= 26,500
Woodland	257 "	@ 100	= 25,700
Roads	20 "	@ 0	= 0
Total	448 Acres		\$224,800

b. Improvements. -

21 Residences with Outbuildings

1 Commercial Property

1 Gun Club Building

\$222,700

Total Land and Improvements

\$447,500

c. Severance Damages

5,000

d. Resettlement

15,975

e. Acquisition Costs

Est. 25 ownership @ \$1,000

25,000

Sub-Total

\$493,475

Contingencies

44,525

TOTAL REAL ESTATE COSTS

\$538,000

Values, costs, and other data contained in this estimate are subject to subsequent refinement when adequate tract data are available and will be more fully discussed in Real Estate Design Memorandum No. 3.

P. RELOCATIONS

48. Relocations. -

a. Roads. - Portions of the roads listed below serving traffic with average daily traffic volumes of 50 - 2,800 vehicles are located within the reservoir area. Actions to be taken for the portions of the roads involved are indicated below:

<u>Road</u>	<u>Action</u>
State Highway Route No. 109	Relocate
Northfield Road	Abandon
Old Morris Road	Raise

Route No. 109 will be relocated for a distance of approximately 1.8 miles on the northerly side of the reservoir.

A portion of Northfield Road, within the reservoir area, will be abandoned. Traffic gates will be constructed at the Guide Taking Line, with one gate at the southerly side of the reservoir on Northfield Road and another at the westerly junction of existing and relocated Route No. 109.

A short section of Old Morris Road north of Route No. 109 will be raised above the Guide Taking Line to meet the grade of the relocated Route No. 109.

A total of approximately 1.9 miles of existing roads within the reservoir will require relocation, raising or improvement and 1.3 miles will be abandoned.

b. Utilities. -

(1) Electric Transmission Lines. A 2-69 kv transmission line of the Connecticut Light and Power Company crosses the spillway outlet channel which will require relocation of one of the supporting structures.

(2) Electric Distribution Lines. The Hartford Electric Company will abandon approximately 2500 feet of single phase primary lines and relocate approximately 4,000 feet of single phase primary lines.

(3) Telephone Cables and Rural Lines. The Southern New England Telephone Company will abandon approximately 2300 feet of overhead lines. In addition, they will remove approximately 5600 feet of 50-22 cable and 4100 feet of 25-22 cable and will install, on relocated Route No. 109, approximately 7500 feet of new 100-24 cable.

(4) Waterbury Water Supply System. - The existing 36-inch water supply aqueduct of the City of Waterbury passes through the reservoir and under the proposed dam and will be submerged by the permanent pool. When the reservoir is full, the water supply line, chlorination building, chemical building and gate houses will be submerged. The City Engineer of the City of Waterbury considers it necessary to construct a gate house above the full pool elevation, a new chemical building which would combine facilities for chlorination and adding other chemicals to the water and replacement of the water supply aqueduct above full pool elevation and connection to the existing water supply aqueduct downstream of the proposed dam. The estimated Government cost of relocating the water supply aqueduct essentially along the relocated Route 109, and raising the appurtenant structures is tentatively estimated to be \$460,000 including contingencies. The relocation of the water supply aqueduct will be discussed in detail in Design Memorandum No. 4 - Relocations.

49. Method of Accomplishment. -

a. Roads. - Relocation of Route No. 109, the new connection to Northfield Road and the raising of a section of Old Morris

Road will be accomplished by the Connecticut State Highway Department under a relocation contract which is subject to the relocation procedure and approval of the Government. The estimated cost of raising and relocating all roads is \$1,600,000 including contingencies. All proposed road relocations and detailed cost estimates will be described in Design Memorandum No. 4 - Relocations.

b. Utilities. - The utility relocations will be accomplished by negotiated agreement with the respective owners. The compensation to the owners will be based on replacement in kind, without betterment, or abandonment and removal where the service is no longer required and will include furnishing engineering services, preparing plans, and accomplishment of the required relocations; all of which are subject to the relocation procedure and approval of the Government. The total cost of utility relocations including the water supply aqueduct is tentatively estimated to be \$483,000, including contingencies. All proposed utility relocations and detailed cost estimates will be described in Design Memorandum No. 4 - Relocations.

Q. COST ESTIMATES

50. Current Cost Estimate. - The total estimated cost of the Black Rock Reservoir Project is \$6,440,000. A summary of the cost of the various features of the work described in this Memorandum is shown in Table I below. Breakdown of the estimate is shown in Table II, Page 32.

TABLE I

SUMMARY OF FEDERAL COSTS (December 1964 Price Level)

<u>Project Feature</u>	<u>Cost</u>
Lands and Damages	\$ 538,000
Relocations	2,083,000
Reservoir	12,000
Dam	2,910,000
Buildings, Grounds & Utilities	44,000
Permanent Operating Equipment	13,000
Engineering and Design	500,000
Supervision and Administration	<u>340,000</u>
TOTAL ESTIMATED PROJECT COST	\$6,440,000

51. Comparison of Estimates. - The following tabulation shows the comparison of the current cost estimate with the latest approved PB-3 cost estimate and with the project document cost estimate:

<u>Cost Account No.</u>	<u>Project Feature</u>	<u>Current Estimate</u>	<u>PB-3 Estimate (1 July 1963)</u>	<u>Project Document Estimate</u>
01	Lands & Damages	\$ 538,000 ⁽¹⁾	\$ 470,000	\$ 428,000
02	Relocations	2,083,000 ⁽²⁾	2,200,000	583,000
03	Reservoir	12,000	12,000	12,000
04	Dam	2,910,000 ⁽³⁾	2,119,000	1,913,000
08	Access Road		65,000 ⁽⁴⁾	65,000
14	Recreational Facilities		65,000	
19	Buildings, Grounds, & Utilities	44,000 ⁽⁵⁾	4,000	4,000
20	Permanent Operating Equipment	13,000 ⁽⁶⁾	5,000	
30	Engineering & Design	500,000	445,000	305,000
31	Supervision & Administration	340,000	305,000	230,000
<u>TOTAL ESTIMATED PROJECT COST</u>		<u>\$6,440,000</u>	<u>\$5,690,000</u>	<u>\$3,540,000</u>

- (1) Previous estimate was based on acquisition of reservoir lands in fee to the 5-year frequency flood flow line and easement for the remainder. The current estimate is based on a minimum guide taking line at 300 feet horizontally from the static full pool elevation.
- (2) New estimate for road relocations is based on revised criteria in accordance with Section 207 (b), P.L. 86-645. Estimate for water supply aqueduct is based on relocating aqueduct outside reservoir area.
- (3) Increase due to flatter slopes of embankment.
- (4) Decrease due to elimination of access road
- (5) Increase due to inclusion of new utility building.
- (6) Permanent operating equipment required for maintenance by full-time operator.

R. SCHEDULE FOR DESIGN AND CONSTRUCTION

52. Design. - Preparation of plans and specifications for the relocation of State Route No. 109 will be completed by the Connecticut State Highway Department in May 1965. Preparation of plans and specifications for the dam and appurtenant structures will be completed in November 1965.

53. Construction. - It is estimated that three full construction seasons will be required for the completion of this project.

54. Relocations. - State Route No. 109 and the water supply aqueduct pass through the dam site. Therefore, the relocations must be initiated early in the construction program to clear the work area for the construction of the dam. It is currently anticipated that construction funds may be included in Fiscal Year 1966 Budget in an amount sufficient to start construction in the spring of 1966. Therefore, the construction of the relocated road and water supply aqueduct will be initiated in the early spring of 1966, and completed in the fall of 1967. The work for the relocated highway will be accomplished under an agreement with the Connecticut State Highway Department which will administer the construction contract. The work for the relocated water supply aqueduct will be accomplished under an agreement with the City of Waterbury which will administer the construction contract. Construction of the relocation of electric distribution, telephone and transmission lines will be accomplished under separate contracts to be negotiated with the respective utility companies in Fiscal Year 1966.

55. Dam and Appurtenant Structures. - Construction of the dam, outlet works, spillway and clearing of the reservoir will be accomplished under a single continuing contract to be awarded late in calendar year 1966.

a. First Season. - During the remainder of the 1966 construction season, the contractor will mobilize and initiate and complete the clearing and grubbing of the site of the structures and borrow area.

b. Second Season. - The contractor will initiate earth and rock excavation for the outlet works and construction of the conduit and the lower part of the intake tower to top of cofferdam elevation 470 feet, mean sea level, will be completed. Preparation of the foundation for the permanent cofferdam, including the cutoff trench will be initiated and completed. The diversion of the river through the outlet works will be accomplished as soon as the permanent cofferdam is completed.

The contractor will initiate the construction of the spillway insofar as the earth and rock will be required for the embankment.

c. Third Season. - Construction will be continued and completed on the outlet works, dam embankment and spillway. The service bridge pier will be completed and the service bridge installed. The utility building will be initiated and completed. Reservoir clearing will be accomplished during the winter between the second and third construction seasons. All work will be completed in the late fall of 1968.

56. Funds Required. - The construction schedule is based on the assumptions that funds for construction of the project will be first appropriated in Fiscal Year 1966, and that additional funds will be appropriated as required. It is therefore estimated that funds will be required by fiscal years approximately as follows:

<u>Fiscal Year</u>	<u>Amounts Required</u>
1966	\$ 400,000
1967	2,700,000
1968	2,100,000
1969	<u>948,000</u>
Sub-Total	\$6,148,000
Allotted thru FY 65	<u>292,000</u>
TOTAL PROJECT ESTIMATE	\$6,440,000

The construction schedule and yearly appropriations required are included as Plate Nos. 5-11 and 5-12.

S. OPERATIONS AND MAINTENANCE

57. General. - The Black Rock Dam and appurtenant structures will be operated and maintained in conjunction with the other flood control reservoirs in the Naugatuck River Basin by the United States under the supervision of the Division Engineer, Waltham, Massachusetts.

58. Operation of Reservoir. - The Black Rock Reservoir will be coordinated with the operation of the Thomaston Reservoir to provide protection to the downstream communities. In order to effectively reduce flood peaks on the lower Naugatuck River, it will be necessary to regulate the three gated reservoirs so as to desynchronize their peak flows with those from the uncontrolled drainage areas and the ungated reservoirs. This operation will be in effect whenever flows are expected to exceed downstream channel capacities at damage centers.

59. Maintenance. - Periodic inspection of the dam and appurtenant structures and equipment will be made. The dam and appurtenant structures will be maintained and operated by a permanent damtender

who will be added to the Naugatuck River Basin complex staff. Maintenance will be based on regular, detailed inspection of the entire works, including all operations necessary to preserve the structures. The staff will be under the general supervision of the Operations Division of the New England Division.

60. Annual Charges. - The estimated annual cost of maintenance and operation of the Black Rock Dam and Reservoir is \$15,000 and the estimated cost of major replacements is \$1,500.

T. RESERVOIR REGULATION

61. Reservoir Regulation. - The proposed flood control plan for the lower Naugatuck River includes the gated reservoirs at Thomaston on the Naugatuck River. Hop Brook Dam on Hop Brook and the ungated reservoirs on Northfield and Hancock Brooks. Protection for the upper Naugatuck River Basin will be provided by East Branch and Hall Meadow Brook Reservoirs which will also reduce peak inflow to Thomaston Reservoir. In order to effectively reduce flood peaks on the lower Naugatuck River, it will be necessary to regulate the three gated reservoirs so as to desynchronize their peak flows with those from the uncontrolled drainage areas and the ungated reservoirs. These three gated reservoirs will be controlled by the operator of the Thomaston Dam. The Black Rock Reservoir will contribute to the protection of the downstream communities of Watertown, Waterbury, Naugatuck, Ansonia, Derby and Shelton. There will be no operator's quarters provided at the Black Rock Dam. Upon instructions from the Reservoir Regulation Section, gate regulation will be accomplished by a revolving team under the supervision of the Thomaston Flood Control Dam Operator.

A hydrologic radio network has been authorized for the Naugatuck River Basin. Included in the network, there will be a radio gage to report the pool elevation at Black Rock upon command to Thomaston Dam and the New England Division.

62. Frequency of Filling. - The frequency of filling curves is shown on Plate No. 1-11 in Design Memorandum No. 1. Since a recreation pool will be maintained at elevation 435 feet, mean sea level, the guide curve shows the estimated frequency of the pool levels above this elevation. Some selected values from the curve are shown in the following table:

<u>Frequency (In Years)</u>	<u>Pool Level (In Feet, msl)</u>
Minimum	435
1	463
2	474
5	487
10	497
25	510
50	520 (spillway crest)

U. ECONOMICS

63. General. - The densely populated Naugatuck River Valley is one of the key industrial concentrations in the United States. The Valley's industries produce about 40 percent of the country's brass and bronze industrial shapes and a large part of the aluminum, zinc and copper products.

The destructive flood of August 1955, caused damages of \$194,000,000 in the reaches of the Naugatuck River below Thomaston Reservoir. Thirty-six lives were lost. A recurrence of this flood under present economic conditions would cause losses estimated at \$227,000,000 without flood protection. The Black Rock project, acting after Thomaston Reservoir with three other authorized reservoirs; Northfield Brook, Hop Brook, and Hancock Brook, would prevent \$12,000,000 in losses in the reaches downstream from Thomaston Reservoir.

64. Annual Benefits. - Annual benefits were derived by determining the difference between annual losses after reductions by the existing Thomaston and Hall Meadow Reservoirs, the local protection at Waterbury and the soon to be completed East Branch Reservoir, and those losses remaining after reductions by four authorized reservoirs acting as a system with Black Rock receiving an equitable share of the benefits. Annual losses were adjusted to reflect the growth which will take place in the areas of project influence over the hundred-year life of the project. Average annual benefits so derived amount to \$335,700 at present day price level.

Assuming that Black Rock is the last added reservoir in a system of seven reservoirs and a local protection project, the annual benefit is \$260,200.

In addition to flood damage prevention benefits, Black Rock Reservoir will provide job opportunities for the local labor that is currently unemployed or underemployed. The reservoir site is located in an area that has been designated as an area of substantial unemployment by the U. S. Department of Labor. Two towns within ten miles of the reservoir site have been designated as ARA areas by the Area Redevelopment Administration.

A redevelopment benefit of \$718,800 was computed for the project based on the estimated cost of local labor hired for the construction of the project that would otherwise be unemployed or underemployed. Expressed as an annual equivalent value, this amounts to \$23,500.

65. Annual Charges. - Annual charges shown in Table II below have been computed in accordance with OCE Circular Letter ENG CW-PD,

Subject: "Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources", dated 15 June 1962, using an economic life of 100 years for the project.

TABLE II
ANNUAL CHARGES

Federal Investment

First Federal Cost	\$6,440,000
Interest during Construction (\$6,440,000 x 0.03125 x 1.5)	<u>301,900</u>
TOTAL FEDERAL INVESTMENT	\$6,741,900

Federal Annual Charges

Interest (\$6,741,900 x 0.03125)	\$ 210,680
Amortization (\$6,741,900 x 0.00151)	10,180
Maintenance and Operation	15,000
Major Replacement	<u>1,500</u>
TOTAL FEDERAL ANNUAL CHARGES	\$ 237,360
ROUNDED TO:	\$ 237,400

66. Benefit-Cost Ratio. -

$$\text{Benefit-Cost Ratio} = \frac{\$359,200}{\$237,400} = 1.5$$

V. RECOMMENDATION

67. Recommendation. - It is recommended that the project plan submitted in this Memorandum be approved as a basis for preparation of Detailed Design Memoranda and contract plans for the Black Rock Dam and Reservoir Project.

TABLE III

DETAILED COST ESTIMATE
(December 1964 Price Level)

01.	<u>LANDS, RESETTLEMENT AND ACQUISITION</u>				\$ 493,475
		Contingencies			<u>44,525</u>
	TOTAL LANDS, RESETTLEMENT AND ACQUISITION				\$ 538,000
02.	<u>RELOCATIONS</u>				
	.1 Roads				\$1,396,000
	.3 Utilities				<u>420,000</u>
		Sub-Total			\$1,816,000
		Contingencies			<u>267,000</u>
	TOTAL RELOCATIONS				\$2,083,000
03.	<u>RESERVOIR</u>				\$ 12,000
04.	<u>DAM</u>				
	<u>Description</u>	<u>Unit</u>	<u>Quantity</u>	<u>Unit Price</u>	<u>Amount</u>
	Preparation of Site	1	Job	L.S.	\$ 25,000
	Control and Diver-				
	sion of River	1	Job	L.S.	25,000
	Common Excavation -				
	General	c.y.	120,000	0.60	72,000
	Common Excavation -				
	Borrow	c.y.	1,000,000	0.40	400,000
	Rock Excavation -				
	Open Cut	c.y.	140,000	2.50	350,000
	Safety Mesh	s.y.	6,600	2.50	16,500
	Line Drilling	s.y.	6,000	2.50	15,000
	Hand-cleaned Bed-				
	rock Surface	sq.	1,000	20.00	20,000
	Compacted Impervious				
	Fill	c.y.	525,000	0.15	78,750
	Compacted Random Fill	c.y.	373,000	0.15	55,950
	Compacted Pervious				
	Fill	c.y.	43,000	1.75	75,250
	Compacted Gravel Fill	c.y.	110,000	2.50	275,000
	Gravel Bedding	c.y.	42,000	1.80	75,600
	Road Gravel	c.y.	1,000	2.30	2,300
	Additional Embankment				
	Rolling	hrs.	100	20.00	2,000
	Rock Slope Protection	c.y.	47,500	2.50	118,750
	Rock Fill	c.y.	92,000	1.50	138,000

TABLE III (Cont'd)

04. DAM (Cont'd)

<u>Description</u>	<u>Unit</u>	<u>Quantity</u>	<u>Unit Price</u>	<u>Amount</u>
Foundation Grouting	l	Job	L.S.	50,000
Concrete - Inlet and Outlet Structures	c.y.	800	37.00	29,600
Concrete - Intake Tower to El. 450	c.y.	1,250	40.00	50,000
Concrete - Intake Tower Above El. 450	c.y.	665	90.00	59,850
Concrete - Transition & Conduit	c.y.	1,500	40.00	60,000
Concrete - Spillway Retaining Walls & Weir	c.y.	1,250	50.00	62,500
Concrete - Service Bridge Pier & Abutment	c.y.	1,400	50.00	70,000
Concrete - Service Bridge Deck	c.y.	130	120.00	15,600
Cement	bbl.	11,000	5.00	55,000
Steel Reinforcement	lb.	625,000	0.15	93,750
Rubber Water Stop	l.f.	1,000	3.50	3,500
Anchors	ea.	90	40.00	3,600
Structural Steel - Miscellaneous	lb.	45,000	0.55	24,750
Structural Steel - Service Bridge	l	Job	L.S.	60,000
Aluminum	lb.	6,500	2.00	13,000
Miscellaneous Metals	lb.	45,000	0.45	20,250
Intake Tower - Super-Structure	l	Job	L.S.	10,000
Gate Vent System	l	Job	L.S.	10,000
Float Well and Accessories	l	Job	L.S.	5,000
Elevator	l	Job	L.S.	25,000
Heating and Ventilation System	l	Job	L.S.	3,000
Gates and Machinery	l	Job	L.S.	50,000
Crane and Hoist	l	Job	L.S.	12,000
Diesel Engine	l	Job	L.S.	10,000
Sump Pump	l	Job	L.S.	1,000
Electrical Work	l	Job	L.S.	30,000
Tile Gage	l	Job	L.S.	3,000

TABLE III (Cont'd)

04. DAM (Cont'd)

<u>Description</u>	<u>Unit</u>	<u>Quantity</u>	<u>Unit Price</u>	<u>Amount</u>
Bitum. Concrete Road Surfacing	s.y.	2,000	2.00	4,000
Cable Guide Railing	l.f.	2,000	2.50	5,000
Chain Link Fencing	l.f.	2,000	3.00	6,000
Topsoil and Seeding	s.y.	3,000	0.50	1,500
Log Boom	1	Job	L.S.	3,000
Sub-Total Dam				\$2,595,000
Contingencies				<u>315,000</u>
TOTAL DAM				\$2,910,000

19. BUILDING, GROUNDS AND UTILITIES

Preparation of Site	1	Job	L.S.	\$ 1,000
Road Gravel	c.y.	250	2.30	575
Bitum. Concrete Road Surfacing	s.y.	450	2.00	900
Utility Building	1	Job	L.S.	25,000
Water Distr. System, incl. well	1	Job	L.S.	8,000
Sewage Disposal System	1	Job	L.S.	2,000
Topsoil and Seeding	s.y.	1,050	0.50	525
Flag Pole	1	Job	L.S.	<u>1,000</u>
Sub-Total Building, Grounds & Utilities				\$ 39,000
Contingencies				<u>5,000</u>
TOTAL BUILDING, GROUNDS & UTILITIES				\$ 44,000

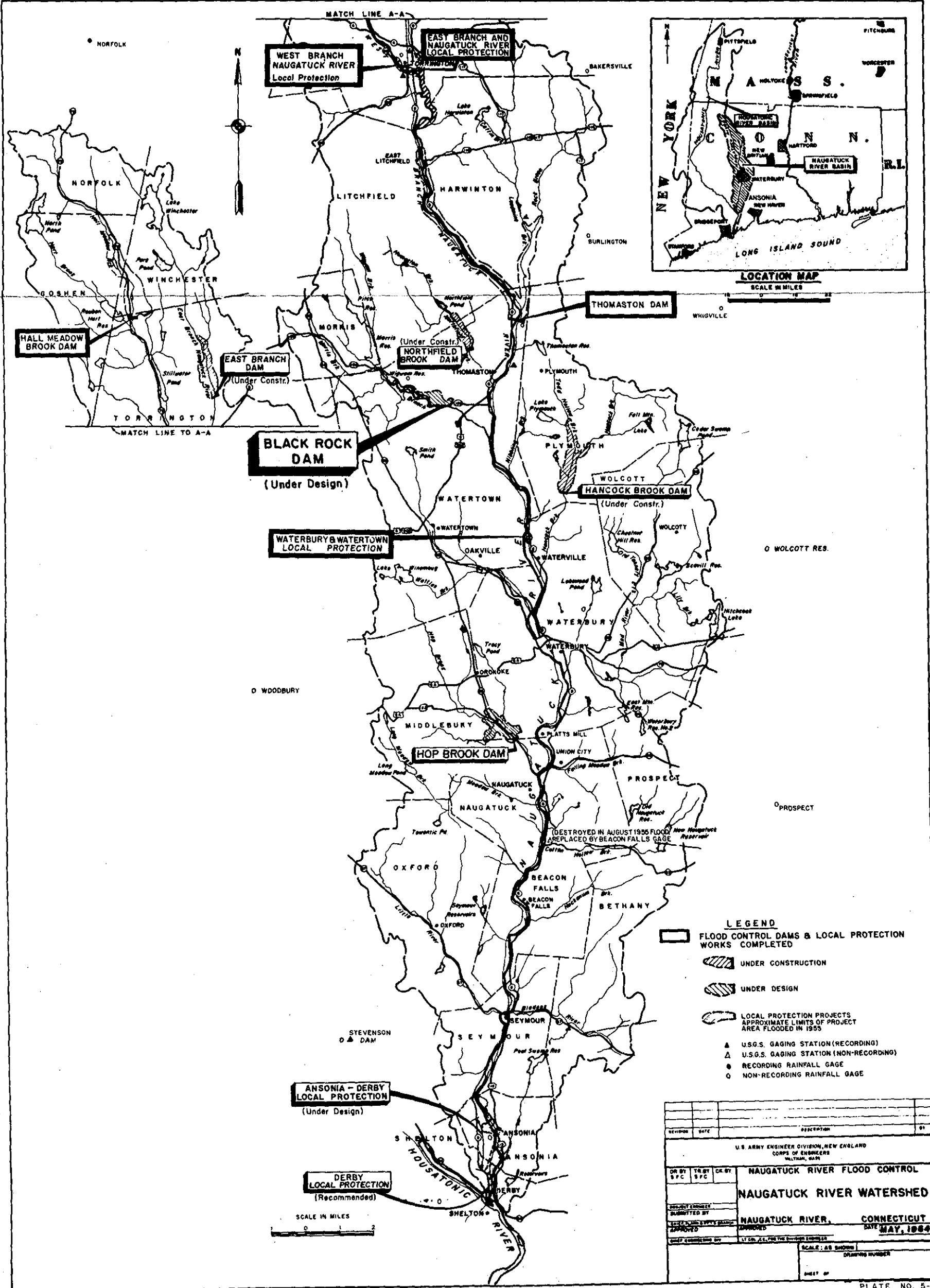
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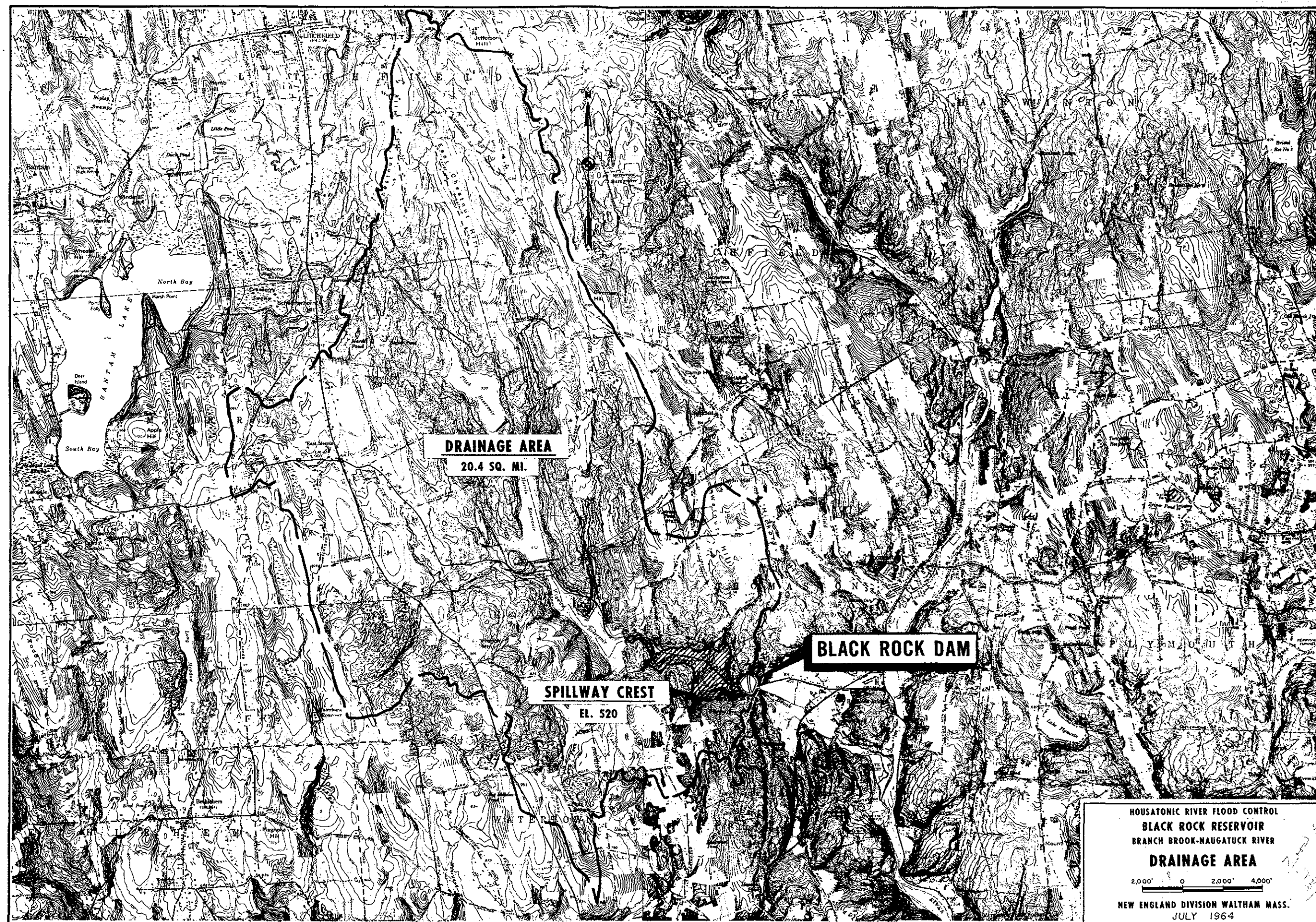
.1 Permanent Operating Equipment	\$ 8,000
.2 Sedimentation Bounds and Ranges	<u>5,000</u>
TOTAL PERMANENT OPERATING EQUIPMENT	\$ 13,000

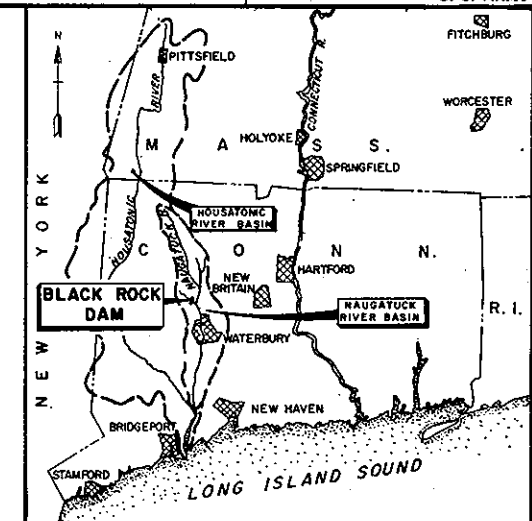
30. ENGINEERING AND DESIGN 500,000

31. SUPERVISION AND ADMINISTRATION 340,000

TOTAL PROJECT FIRST COST \$6,440,000







LOCATION MAP
SCALE: 1" = 16 MILES (APPROX)

FLOW LINE AT
SPILLWAY CREST
EL. 520.0

PROPOSED RELOCATION OF ROUTE 109

PERMANENT POOL
EL. 435.0

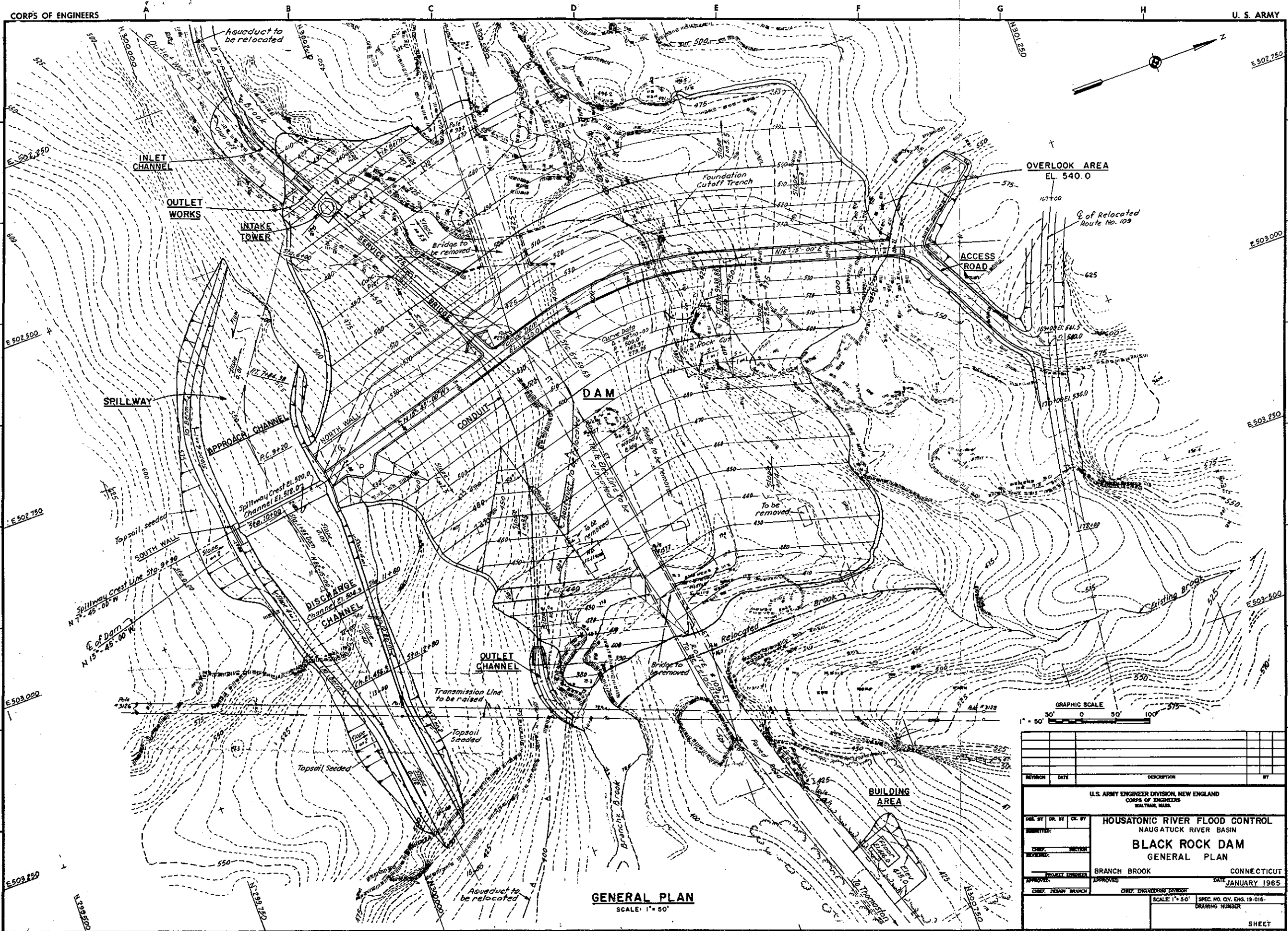
DAM

SPILLWAY

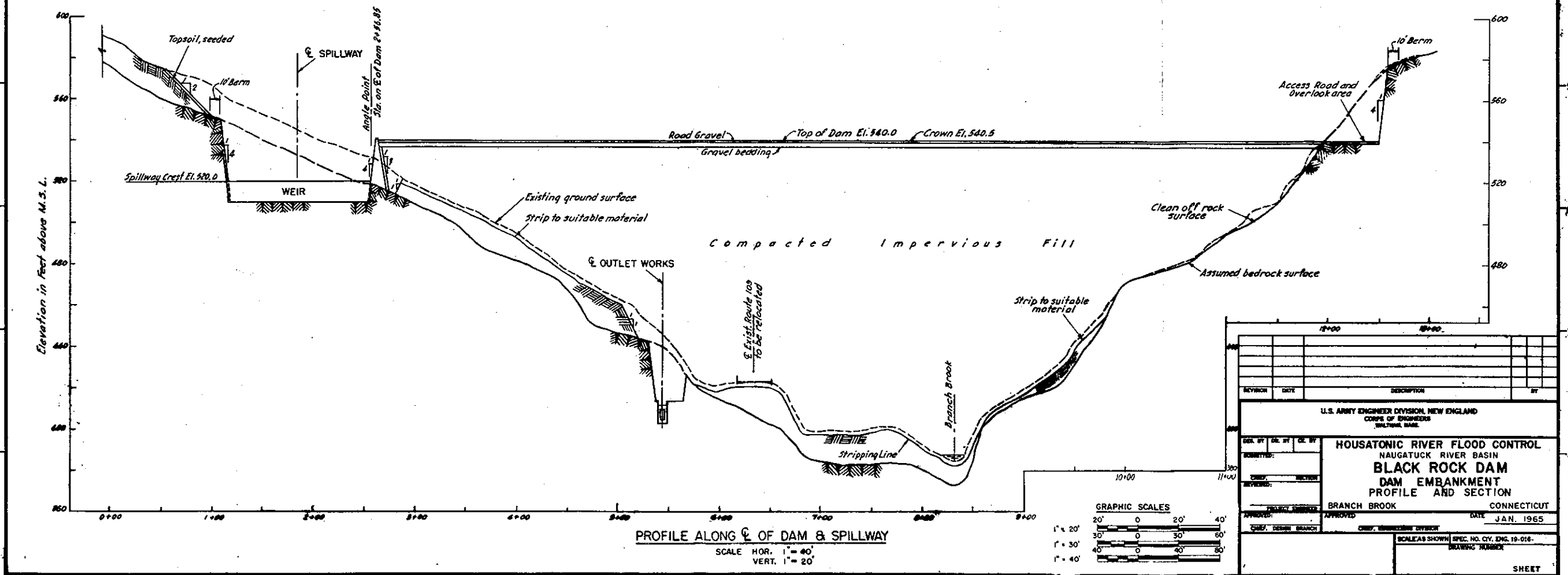
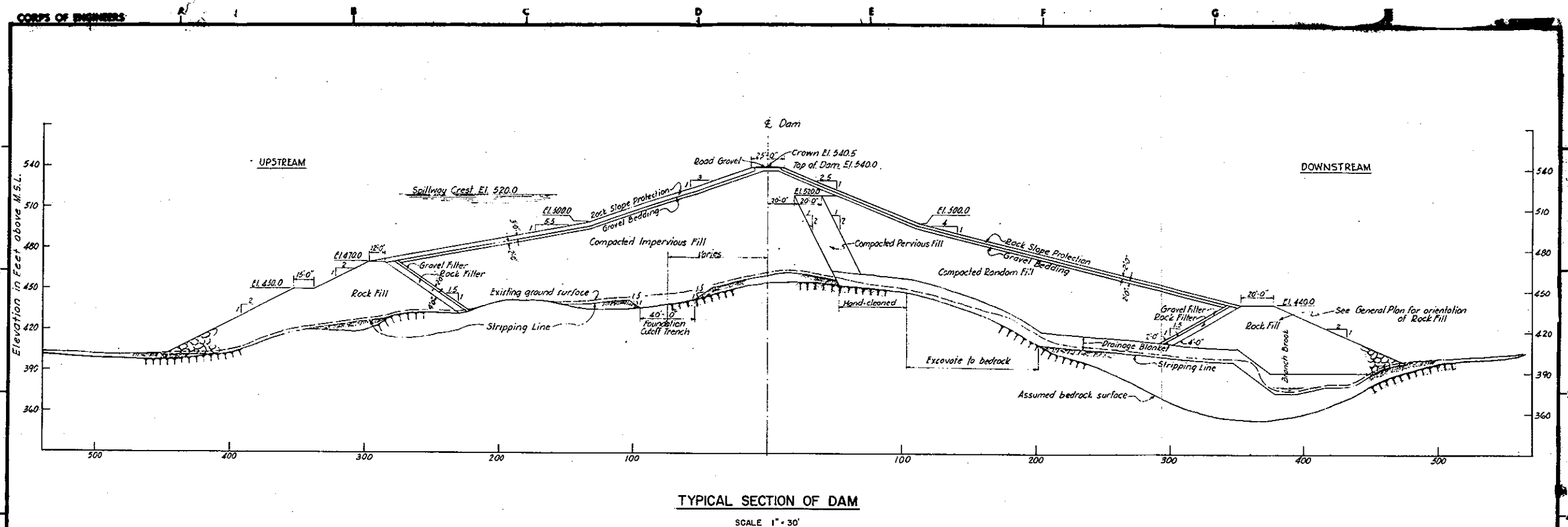
OUTLET 1

RESERVOIR PLAN
SCALE: 1" = 400'

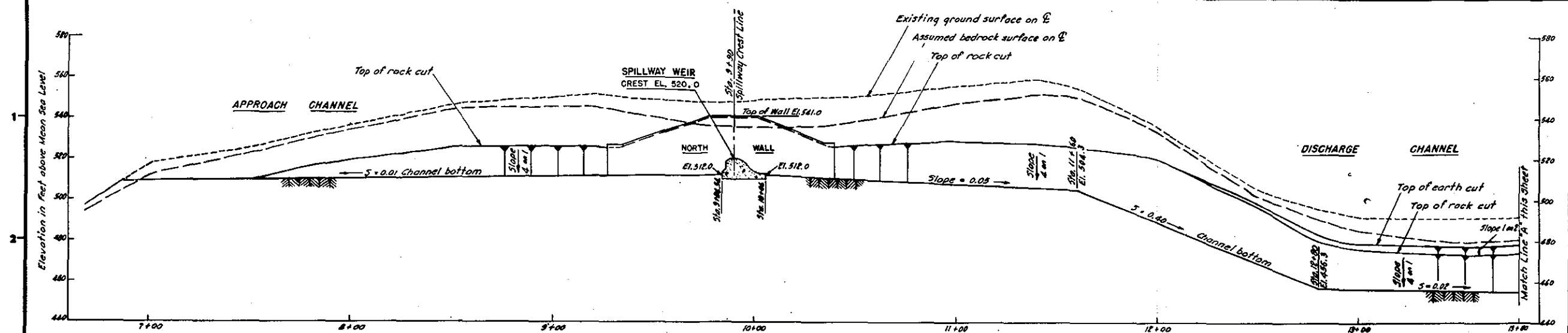
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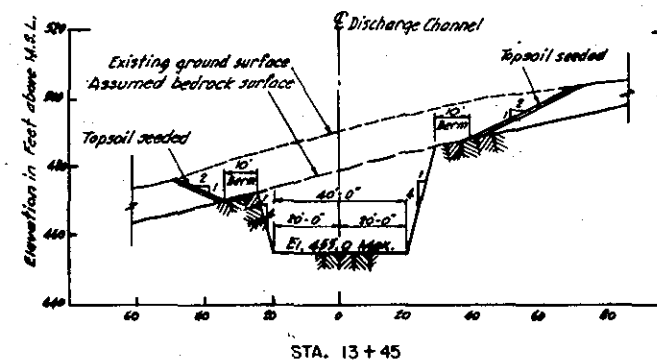
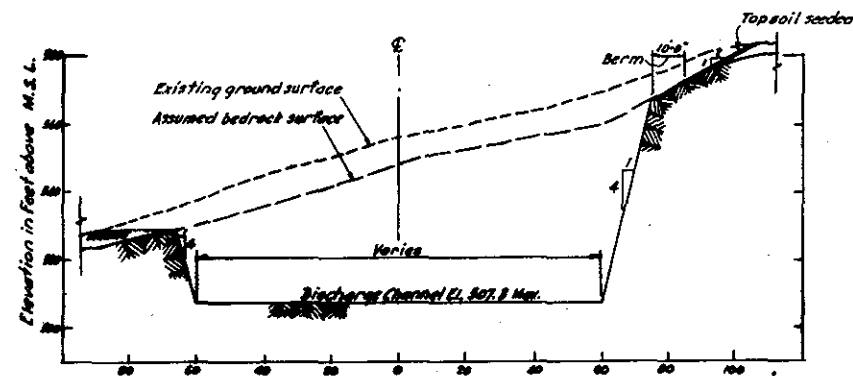
GRAPHIC SCALE 0 50 100 150			
REVISION	DATE	DESCRIPTION	BY
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.			
HOUSATONIC RIVER FLOOD CONTROL NAUGATUCK RIVER BASIN			
BLACK ROCK DAM GENERAL PLAN			
BRANCH BROOK		CONNECTICUT	
APPROVED		DATE JANUARY 1965	
SHEET		SCALE 1" = 50'	
SPEC. NO. CIV. ENL. 19-016		DRAWING NUMBER	



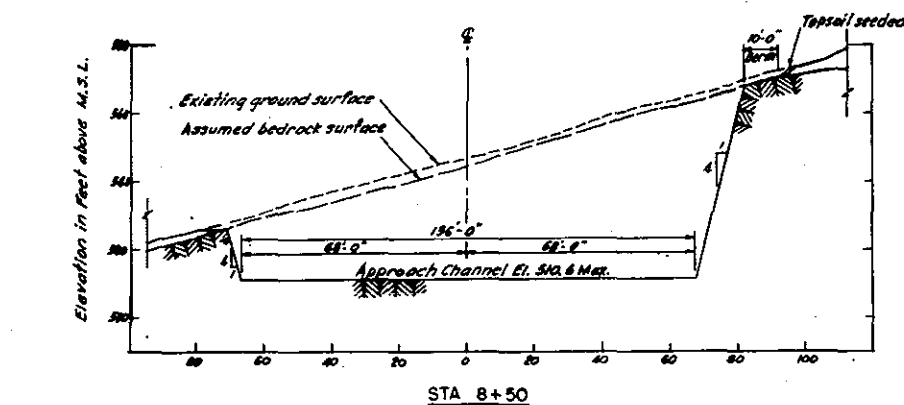
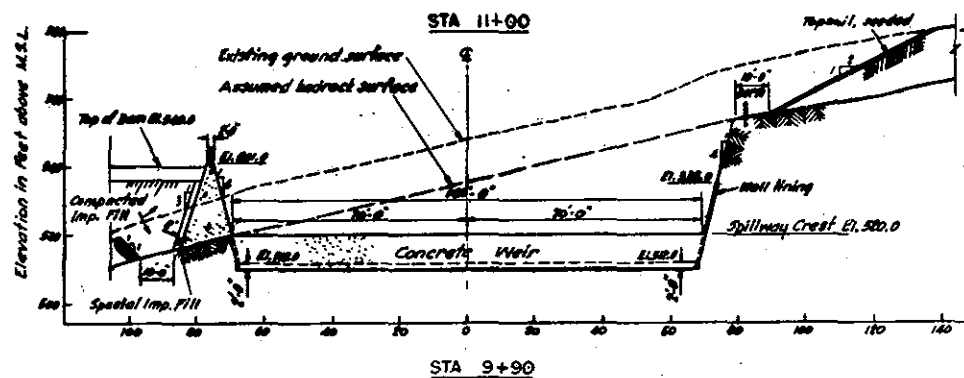




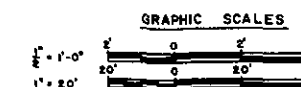
PROFILE ON E OF SPILLWAY CHANNEL
SCALE 1" = 20' HOR. & VERT.



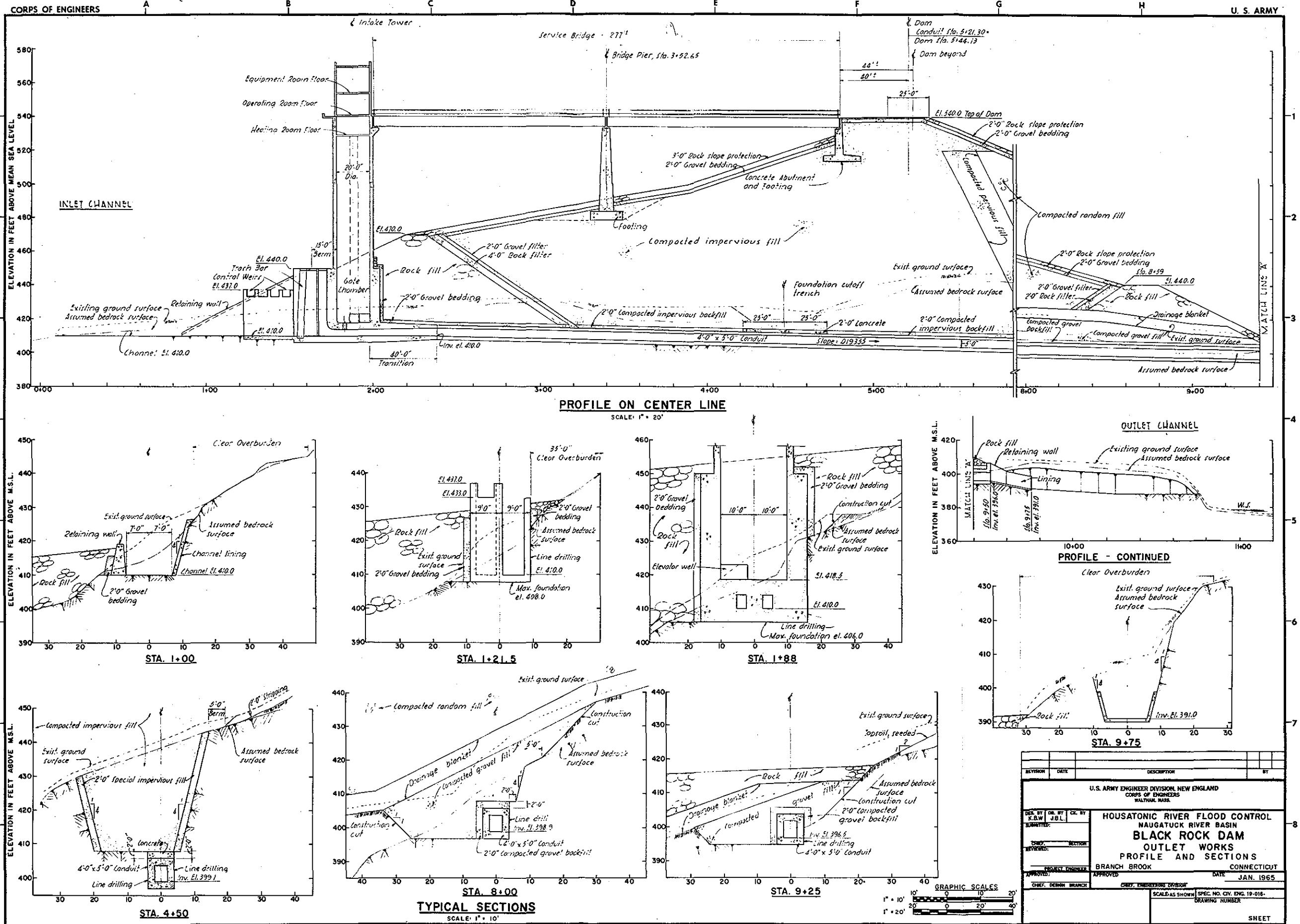
PROFILE - CONTINUED



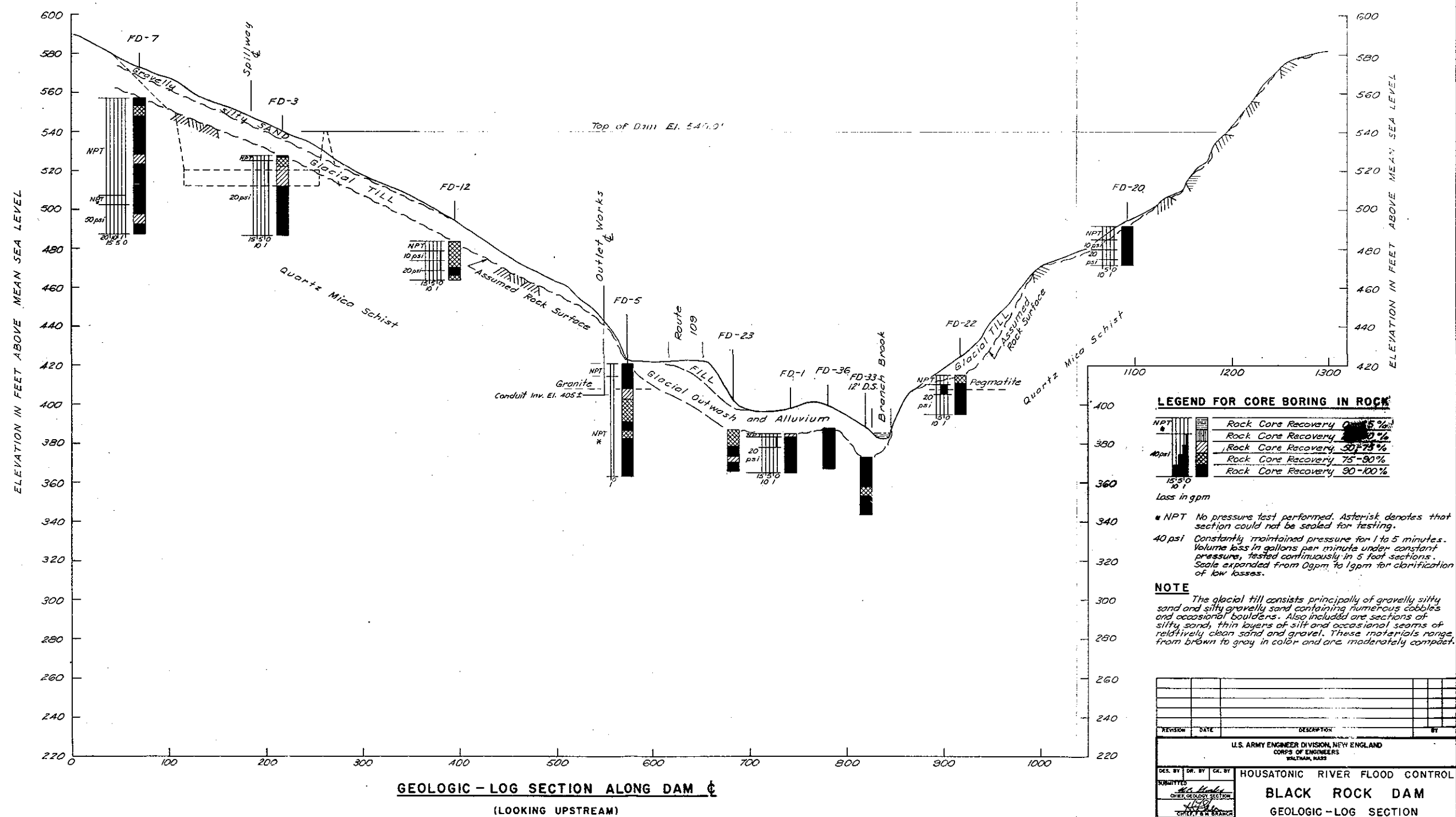
TYPICAL SECTIONS
SCALE 1" = 20' HOR. & VERT.



DESIGNED BY	CHECKED BY	DATE	DESCRIPTION	BY
U. S. ARMY ENGINEER DIVISION, NEW ENGLAND CORPS OF ENGINEERS WILMINGTON, MASS.				
HOUSATONIC RIVER FLOOD CONTROL NAUGATUCK RIVER BASIN BLACK ROCK DAM SPILLWAY PROFILE AND SECTIONS BRANCH BROOK CONNECTICUT APPROVED: _____ DATE: AUGUST 1964 SHEET				

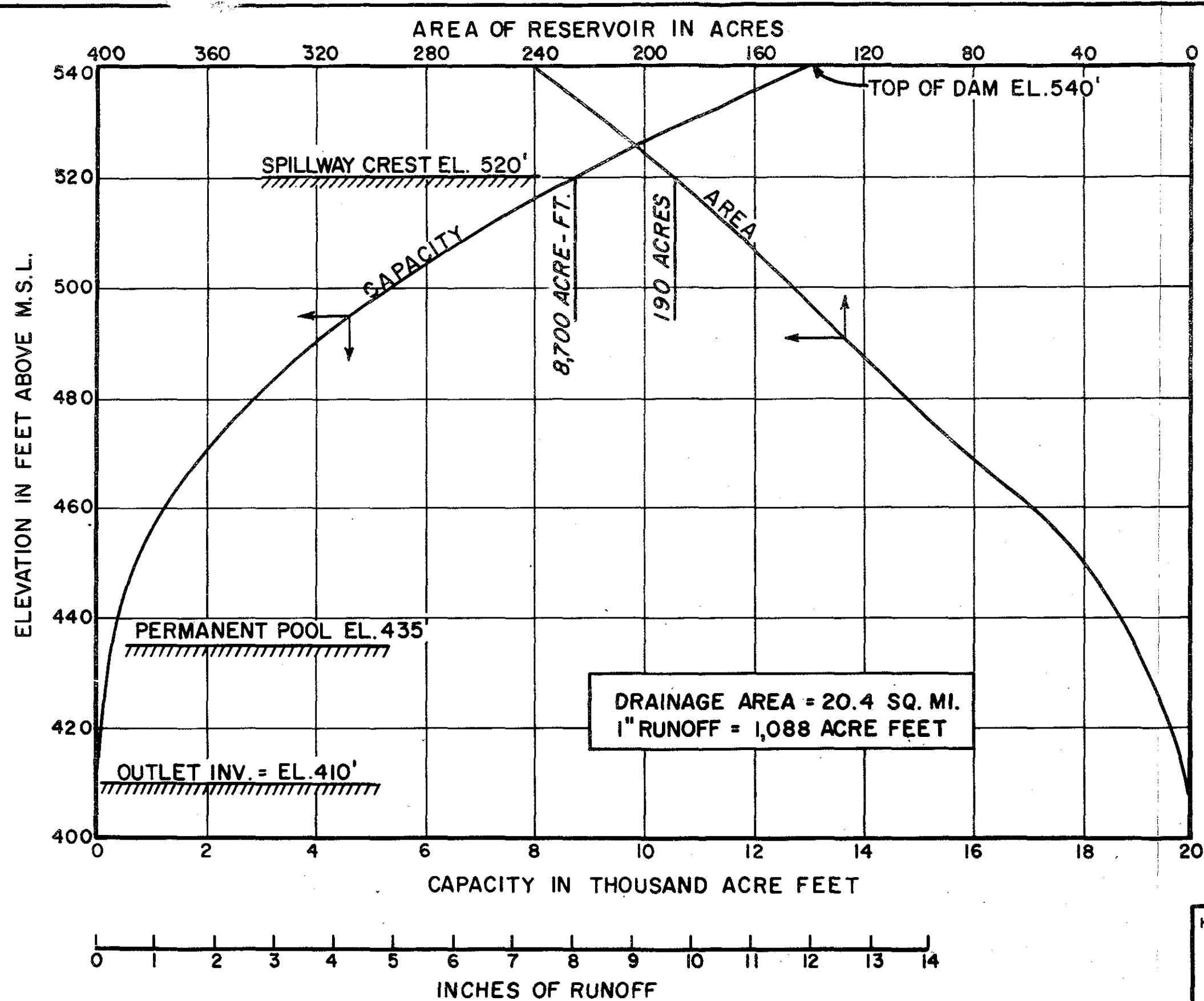






REVISION	DATE	DESCRIPTION	BY

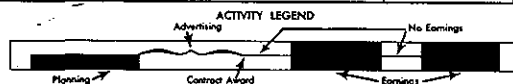
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.			
HOUSATONIC RIVER FLOOD CONTROL			
BLACK ROCK DAM			
GEOLOGIC-LOG SECTION			
DES. BY: DR. BY: CH. BY:	PROJECT ENGINEER		
SUBMITTED: <i>[Signature]</i>	APPROVED: <i>[Signature]</i>		
CHIEF, GEOLOGY SECTION	CHIEF, ENGINEERING DIVISION		
CHIEF, DESIGN BRANCH	CHIEF, CONSTRUCTION BRANCH		
DATE: JULY 1964	SCALE: SPEC. NO. CEN. ENG.-19-016		
DRAWING NUMBER		SHEET	



HOUSATONIC RIVER FLOOD CONTROL
 BLACK ROCK RESERVOIR
 BRANCH BROOK CONN.
 AREA-CAPACITY CURVES
 JULY 1964
 U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
 CORPS OF ENGINEERS WALTHAM, MASS

APP. 10N TITLE: Construction, General
CLASSIFICATION: RESERVOIRS (FLOOD CONTROL)

PROJECT: BLACK ROCK RESERVOIR, CONNECTICUT



DETAILED PROJECT SCHEDULE (PB-2A)

LINE NO.	COST ACCOUNT NO.	ITEM	CONT. TYPE & NO.	QUANTITY, SIZE, OR CAPACITY; DATE OF AWARD (As Applicable)	PROJECT COST ESTIMATE	TOTAL AS OF JUNE 30, 1964	(TO BE REPORTED IN THOUSANDS OF DOLLARS)																BALANCE TO COMPLETE
							CURRENT FISCAL YEAR 1965					BUDGET FISCAL YEAR 1966					FUTURE FISCAL YEARS						
							TOTAL	1st	2nd	3rd	4th	TOTAL	1st	2nd	3rd	4th	1967	1968	1969	1970			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)			
1	01.	LANDS AND DAMAGES		448 ac.	538.0	2.7	17.3	2.3		5.0	10.0	100.0	10.0	10.0	40.0	40.0	225.0	193.0					
2																							
3	02.	RELOCATIONS			2,083.0							160.0		5.0	40.0	115.0	1,678.0	245.0					
4																							
5	.1	ROADS																					
6		Lands			(35.0)							(25.0)		(5.0)	(20.0)		(10.0)						
7		Roads	c.c.	1.9 miles 1/66	(1,565.0)							(120.0)			(20.0)	(100.0)	(124.50)	(200.0)					
8																							
9	.3	UTILITIES																					
10		Water Supply Line	c.c.	3/66	(460.0)							(15.0)				(15.0)	(400.0)	(45.0)					
11		Electric and Telephone	L.S.	7/66	(23.0)												(23.0)						
12																							
13	03.	RESERVOIR A3-1	c.c.	11/66	12.0														12.0				
14																							
15	04.	DAM A3-2	c.c.	1,230,000 cu. y. 11/66	2,910.0												660.0	1,480.0	770.0				
16																							
17	19.	BUILDINGS, GROUNDS & UTILITIES A3-3	c.c.	11/66	44.0														44.0				
18																							
19	20.	PERMANENT OPERATING EQUIPMENT			13.0														13.0				
20																							
21	.1	EQUIPMENT	P.O.		(8.0)														(8.0)				
22																							
23	.2	SEDIMENTATION BOUNDS AND RANGES			(5.0)														(5.0)				
24																							
25	30.	ENGINEERING AND DESIGN			500.0	160.7	89.3	37.3	20.0	15.0	17.0	125.0	45.0	30.0	30.0	20.0	50.0	50.0	25.0				
26																							
27	31.	SUPERVISION AND ADMINISTRATION			340.0	13.7	8.3	3.3	2.0	1.0	2.0	15.0	4.0	3.0	3.0	5.0	87.0	132.0	84.0				
28																							

PLATE 5-11

APPROPRIATION TITLE: Construction, General
CLASSIFICATION: RESERVOIRS (FLOOD CONTROL)

PROJECT: BLACK ROCK RESERVOIR, CONNECTICUT



DETAILED PROJECT SCHEDULE (PB-2A)

LINE NO.	COST ACCOUNT NO.	ITEM	CONT. TYPE & NO.	QUANTITY, SIZE, OR CAPACITY; DATE OF AWARD (As Applicable)	PROJECT COST ESTIMATE	TOTAL AS OF JUNE 30, 1964	(TO BE REPORTED IN THOUSANDS OF DOLLARS)																BALANCE TO COMPLETE	ON JAN																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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PLATE 5-12

FEDERAL POWER COMMISSION
REGIONAL OFFICE
346 Broadway
New York 13, New York

May 24, 1963

Division Engineer
U. S. Army Engineer Division, New England
424 Trapelo Road
Waltham 54, Massachusetts

Ref. File No. NEDGB

Subject: Black Rock Dam and Reservoir
Branch Brook, Connecticut

Dear Sir:

Reference is made to your letter of April 30, 1963 requesting our present views on the power potentialities of the proposed Black Rock Reservoir project as given in our letter of December 21, 1956. At that time our staff considered the possibility of developing power in conjunction with flood control by raising the dam to provide head and additional storage.

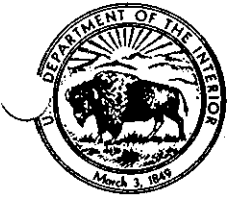
Under this plan the firm power would be less than 100 kilowatts with an average annual potential energy output of about 1.7 million kilowatt-hours. It was concluded that the costs associated with development of this small amount of power would greatly exceed the value thereof, and therefore modification of the project to provide for power development would not be warranted.

Inasmuch as the project is to be planned and constructed without multiple-purpose features or any other changes in the original plan, we find no reason to modify our prior conclusions with respect to power development at the Black Rock Dam.

Sincerely yours,


D. J. Wait
Regional Engineer

EXHIBIT NO. 1



UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
59 TEMPLE PLACE
BOSTON, MASSACHUSETTS 02111

April 1, 1964

Division Engineer
U. S. Army Engineer Division, New England
Corps of Engineers
424 Trapelo Road
Waltham 54, Massachusetts

Dear Sir:

Thank you for your letter of February 28, 1964 advising us of revisions in plans for the Black Rock Reservoir, Connecticut. It is our understanding that the spillway crest elevation has been increased by seven feet and the flood control pool increased from 180 acres to 190 acres. The area of the permanent pool is changed from 15 to 21 acres while its maximum depth will be reduced from 36 to 35 feet. The new surface elevation of the permanent pool will be 435 feet m.s.l., an increase of 15 feet from the original plan. The reservoir will be cleared to an elevation three feet above the permanent pool.

We have discussed the revised plans with personnel of the Connecticut State Board of Fisheries and Game and have agreed that changes in project plans do not necessitate any revision of our previous report dated April 25, 1960.

Sincerely yours,

Thomas A. Schrader, Chief
Division of Technical Services



ADDRESS ONLY THE
REGIONAL DIRECTOR

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
59 TEMPLE PLACE
BOSTON, MASSACHUSETTS

NORTHEAST REGION
(REGION 5)
MAINE
NEW HAMPSHIRE
NEW YORK
VERMONT
PENNSYLVANIA
MASSACHUSETTS
NEW JERSEY
RHODE ISLAND
DELAWARE
CONNECTICUT
WEST VIRGINIA

April 25, 1960

Division Engineer
New England Division
U. S. Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts

Dear Sir:

This letter constitutes our report on the fish and wildlife aspects of 4 proposed flood control reservoirs on the Naugatuck River in Litchfield and New Haven Counties, Connecticut. These sites include Black Rock, Hancock Brook, Hop Brook and Northfield Brook, none of which have been authorized. This report has been reviewed by the Connecticut State Board of Fisheries and Game. The report, and specifically the recommendations which follow, have been endorsed by the Connecticut State Board of Fisheries and Game as indicated in the letter to me dated March 17, 1960, from Director Lyle M. Thorpe of that Board, a copy of which is appended.

Comments were previously submitted concerning these and other sites in our letters of December 14, 1956, and May 22, 1958.

The 4 projects under consideration are located on tributaries to the Naugatuck River, in the Housatonic River Basin. The tributaries enter the Naugatuck downstream from the Thomaston Dam and Reservoir currently under construction. None of the proposed sites are farther than 9 miles from the city of Waterbury, the largest population center in this highly industrialized and urbanized basin.

DESCRIPTION OF FISH AND WILDLIFE RESOURCES
IN RELATION TO PROJECT PLAN

Hancock Brook Dam and Reservoir

Project Plan

The Hancock Brook Dam site is located in the town of Plymouth 3.4 miles upstream from the confluence of Hancock Brook and the

EXHIBIT NO. 2-2

Naugatuck River. At the spillway crest elevation of 484 feet,^{1/} the flood pool will have a surface area of about 265 acres. The dam will be 50 feet high, 615 feet long and will store 3,820 acre-feet of water. The 5-year flood pool at elevation 475 feet will have a surface area of approximately 200 acres. The dam will be provided with a 48-inch ungated conduit. The surcharge elevation will be 10 feet above the spillway.

Fish and Wildlife Resources (Without the Project)

Hancock Brook is an important local trout stream. The State Board of Fisheries and Game stocks this stream annually with large numbers of trout. In 1959 a total of 1,450 yearling, and 25 2-year-old brook trout, 500 2-year-old brown trout, and 75 2-year-old rainbow trout were stocked. This fishery resource provides about 3,000 angler-days of recreation every year.

The reservoir area differs from the other 3 projects in that it encompasses a large area of brushy swampland. Almost the entire area offers good to excellent habitat for cottontail rabbit and pheasant. Lesser amounts of habitat are available for waterfowl, grouse, woodcock, squirrel, mink and muskrat. The State regularly stocks pheasant in the site and in 1959, 125 adult birds were released. About 2,000 hunter days are expended in harvesting the stocked pheasants and the other resident and migratory game species.

Fish and Wildlife Resources (With the Project)

Periodic flooding within the reservoir area will inundate long reaches of streams within the site due to the low gradient of the basin. Over 2.8 miles of Hancock and Todd Hollow Brooks will be inundated whenever the reservoir reaches the spillway crest elevation. Every year a total of about 2 miles of streams will be inundated and 2.4 miles will be inundated every 5 years. It is expected that the trout habitat within the stream mileage annually inundated will be depreciated considerably in value. Streams encompassed in flood storage pools to be held at less frequent intervals will suffer less damaging effects. Trout habitat below the dam site will suffer some temporary damages from siltation during project construction.

The anticipated annual flood pool will inundate about 130 acres of good small game habitat. Every 5 years, about 200 acres will be inundated and at the spillway crest elevation, about 265 acres will be inundated. Some changes in the vegetative composition

^{1/} All elevations in this report are in feet and refer to mean sea level datum.

resulting from inundation can be expected, but this change will probably be minimal within the 1-year level since existing vegetation is adapted to a certain amount of flooding. Indiscriminate borrow operations would cause more serious losses to the wildlife resource at Hancock Brook than at any of the other reservoir sites.

Northfield Brook Dam and Reservoir

Project Plan

The Northfield Brook Dam site is located 1 mile upstream from the confluence of Northfield Brook and the Naugatuck River in Thomaston. The 118-foot high dam will be approximately 800 feet long and is designed to store 2,430 acre-feet of water. A pool held at spillway crest elevation of 573 feet will have a surface area of about 60 acres. The spillway is designed for a 10-foot surcharge. The 5-year flood pool will have a surface area of about 35 acres at elevation 540. Control of the reservoir will be accomplished by means of a 36-inch ungated conduit.

Fish and Wildlife Resources (Without the Project)

Northfield Brook is a locally important trout stream and receives moderate angling pressure. The stream is stocked annually by the State. In 1959, 150 yearling brook trout were stocked and these were supplemented by some natural reproduction in the stream.

The 60-acre reservoir area provides very limited habitat for small game species, due to present land uses and the proximity to the highway. Hunting pressure on the area is negligible.

Fish and Wildlife Resources (With the Project)

At the spillway crest elevation the reservoir pool will inundate 1.2 miles of Northfield Brook. Every year approximately a $\frac{1}{2}$ mile of stream will be inundated and about 0.6 mile will be inundated every 5 years. Periodic flooding will result in direct losses to the production and utilization of the fishery resource.

Potential wildlife production and utilization with the reservoir area will be detrimentally effected. Changes in vegetative composition can be expected, more notably in the lower most frequently flooded portions of the reservoir, which will influence utilization by wildlife species.

Hop Brook Dam and Reservoir

Project Plan

The Hop Brook dam site is located on Hop Brook in the town of Middlebury about 1.2 miles upstream from the confluence of Hop Brook and the Naugatuck River. A small portion of the reservoir area at the dam site lies within Whittemore Glen State Park.

The proposed dam will be approximately 470 feet long, 82 feet high and will store 6,840 acre-feet of water. The surcharge elevation will be 10 feet above the spillway crest. At spillway crest elevation of 362 feet, the surface area of the flood pool will be about 280 acres. Flows through the 48-inch conduit will be controlled by means of 2-3 X 3 foot hydraulically operated gates. The 5-year flood pool at elevation 342 feet would inundate about 150 acres.

Fish and Wildlife Resources (Without the Project)

Hop Brook is considered a locally important trout stream and is stocked annually. In 1959, the State released 1,400 yearling brook trout, 25 2-year-old brook trout and 150 2-year-old brown trout. It is estimated that the stream provides 2,250 angler-days of recreation annually.

The partly wooded reservoir area provides high quality small game habitat and involves lands where the State Board of Fisheries and Game has hunting agreements with landowners. These occur at the upper part of the reservoir site and form part of the Naugatuck Regulated Shooting Area. Despite some posting against access, the project area provides a total of about 1,220 hunter-days recreational annually, about three quarters of this hunting effort being expended in harvesting rabbit, woodcock, grouse, and squirrel. The remainder is accounted for by hunters seeking pheasant which are stocked by the State.

Fish and Wildlife Resources (With the Project)

The reservoir pool at spillway crest elevation would inundate about 1.6 miles of Hop Brook, 0.8 mile of Wooster Brook and 0.3 mile of Welton Brook. Every year, the flood pool is expected to reach an elevation which will inundate 1.2 miles of Hop Brook and 0.5 mile of Welton and Wooster Brooks. Construction activities, annual flooding, and the permanent pool will eventually cause the loss of some, if not all, of the trout angling opportunities now existing.

Flooding to the spillway crest is expected only infrequently; therefore upper elevation areas, including that part of the Naugatuck Regulated Shooting Area within the site, will be subject to minor effects. Frequent flooding to lower elevations will result in more apparent changes in vegetative cover and use by wildlife. Production of wildlife species will be adversely affected, utilization of habitat will be restricted and hunter utilization of this resource will be limited because of flooding at various seasons of the year. Annually, about 90 acres will be flooded and approximately 150 acres will be inundated every 5 years. State Park lands, where hunting is prohibited, accounts for about 14 acres at the annual flood pool area and 20 acres at the 5-year level.

Black Rock Dam and Reservoir

Project Plan

The dam site for the Black Rock project is located on Branch Brook, 1.8 miles upstream from its confluence with the Naugatuck River in Thomaston. Over 70 percent of the reservoir area will lie within the boundaries of Black Rock State Park. A dam 153 feet high and approximately 1,100 feet long will store 8,860 acre-feet of water. At the spillway crest elevation of 513 feet, the reservoir will have a surface area of 180 acres. The 5-year flood pool will have a surface area of 115 acres at elevation 477. Operation of the dam will be accomplished by means of a 54-inch conduit with 2-3 foot by 4 foot hydraulically operated gates. The spillway is designed for a 15-foot surcharge.

Fish and Wildlife Resources (Without the Project)

Branch Brook is considered an excellent trout stream. The Fish Division, of the Connecticut State Board of Fisheries and Game, is using sections of this stream as a study area. In 1959 the stream was stocked with 575 yearling brook trout and 200 2-year-old brown trout. Natural brown trout reproduction provides additional fish for the angler. The fishery resource provides approximately 1,500 angler-days of recreation annually.

Hunting is prohibited in Black Rock State Park, and since the major portion of the reservoir area is State Park land the very small acreage open to hunting receives light pressure. The greater part of the reservoir area is forested and provides good habitat for grouse, squirrels and rabbit.

Fish and Wildlife Resources (With the Project)

At the spillway crest elevation the reservoir will inundate 1.3 miles of Branch Brook. Slightly over a mile of stream will be inundated by the annual flood pool which will be 74 feet deep at the dam. Periodic inundation will result in losses to the stream fishery through siltation, and prevention of angling for short periods of time during and after the flooding period.

DISCUSSION

The Naugatuck River Basin has a population greater than 215,200, of which 90 percent live in urbanized areas of the 5 cities and 28 towns. As an indication of the demands placed on the fish and wildlife resources of the project area, the number of licensed sportsmen within a 10-mile radius of each site averages about 15,000, expending about 77,000 man-days afield annually. Under existing conditions, the project areas meet about 3 percent of this demand, with

the Hop Brook and Hancock Brook areas bearing the greater share of use. If recommendations contained in this report are followed, it is expected that the reservoir areas will be able to meet the maximum possible share of the local demand.

It is understood that the planning agency is recommending the inclusion of permanent pools at each site. At Hancock Brook, a permanent pool at elevation 460 would provide a surface area of 54 acres 6 feet deep at the dam. A large portion of this pool would be less than 3 feet deep. A permanent pool at Northfield Brook would be held at elevation 497 and have a surface area of 7.5 acres 25 feet deep at the dam. At Hop Brook, a permanent pool at elevation 310 would have a surface area of 25 acres and be 14 feet deep at the dam. At elevation 420, a permanent pool at Black Rock would be 36 feet deep at the dam and have a surface area of 15 acres. Reservoir clearing operations will be conducted within the maximum permanent pool level at the 4 sites.

Provision for control of water levels and for drawdown at each permanent pool are important to the management of the fish and wildlife resources. Stop-log type structures appear to be most desirable, and should control the entire elevation of the permanent pools at Hancock Brook and Hop Brook. Control of the upper 10-15 feet of the Black Rock pool, and provision for drawdown of the Black Rock and Northfield Brook permanent pools will be satisfactory. The permanent pools will be managed in a manner not inconsistent with authorized project purposes and the possibility exists that the pools may be drawn down at times for indefinite periods.

Provisions for the inclusion of permanent pools at each of these 4 reservoir sites with water control structures will adequately mitigate fish and wildlife losses resulting from project construction. In addition, it is felt that the measures discussed in the following paragraphs will create further fish and wildlife benefits at no more than incidental cost to the project.

The Hancock Brook site appears to have high potential value as a fish and wildlife management area. The State Board of Fisheries and Game desires that a General Plan for the conservation and development of fish and wildlife resources be executed for this reservoir area. They feel that the best present use of the Hancock Brook reservoir will be to develop it as a small game public hunting area under an intensive management plan. This plan will be geared primarily to developing the most effective pheasant management program, although benefits will accrue to other game species as well. Pheasant stocking, as a management feature, will be employed in a manner best suited to habitat conditions and hunter pressure. Modification of habitat, including that which provides wildlife food as well as cover, will be undertaken in order to adapt the area to best fit into this intensive type management plan. Under a wildlife

management plan, it is anticipated that the permanent pool will be held only periodically for management purposes such as control of vegetation, and so long as the downstream area of Hancock Brook maintains its value for trout.

Those portions of existing roads within the project sites and the railroad bed at the Hancock Brook site, will be valuable for future public access to the reservoir areas and permanent pools. While it is realized that some deterioration of these roads is inevitable during project construction, this deterioration should be minimized as much as possible.

A public access to the pool at the Hop Brook site appears feasible where Route 63 will enter the upper end of the pool. The point where Litchfield Street will enter the upper end of the permanent pool at the Northfield Brook site appears to be the most feasible location for a public access and boat launching point. It is understood that the Corps of Engineers will provide public access, including boat launching and vehicle parking facilities, at these 4 reservoir areas. Therefore, specific provisions for public access have not been made the subject of a recommendation.

Since all of the reservoir sites are small, construction activities and borrow operations will be more or less concentrated. Destruction of the existing vegetation along extensive portions of stream banks will increase damages to existing fisheries. Discharges of large quantities of mud and silt into the streams during construction will damage downstream fisheries values. It is realized that it is impossible to prevent silting of streams during construction operations, without involving additional costs. However, in order to minimize damages to fish and wildlife resources during construction it is recommended that representatives of this office and the State Board of Fisheries and Game be consulted at the time contract specifications are drawn up. It may be possible for fish and wildlife personnel to suggest at this time, means for reducing damages as a procedure in assuring that the reservoir area is left in as good a condition as possible for public use following construction.

The State Board of Fisheries and Game considers the expansion of lands for public hunting and fishing a key endeavor in its overall program. The State Board of Fisheries and Game desires to make an attempt to obtain hunting and fishing rights on lands upon which the construction agency will take flowage easements at the Hop Brook, Northfield Brook and Hancock Brook sites. The best means of accomplishing this appears to be through close coordination with the construction agency when that agency takes the flowage easements. This would mean that a State representative would negotiate for hunting and fishing rights at the same time as a representative of the construction agency is taking flowage easements.

Continuance of the existing commercial sand and gravel operations within the Hancock Brook reservoir site would be detrimental to fish and wildlife management of the reservoir area. Elimination of stream silting from this operation would improve the fishery potential of the stream, and the permanent pool.

RECOMMENDATIONS

We recommend:

1. That provisions be made for permanent pools at each site with approximately the following depths at the dam: Hancock Brook Dam, 6 feet; Northfield Brook Dam, 25 feet; Hop Brook Dam, 14 feet; and Black Rock Dam, 36 feet.

2. That permanent pool water control structures provide for the following: control of the entire pool elevation at Hancock Brook Dam and Hop Brook Dam; drawdown of the pool at the Northfield Brook Dam; and control of the upper 10-15 feet and drawdown at the Black Rock Dam.

3. That Federal lands and included water areas within the Hancock Brook project area, be made available to the Connecticut State Board of Fisheries and Game in accordance with a General Plan for wildlife management as provided in Sections 3 and 4 of the Fish and Wildlife Coordination Act, except for such portions as may be reserved by the construction agency for reasons of safety, efficient operation or protection of public property.

4. That insofar as possible the following roads and railroad bed within reservoir boundaries be preserved for public access purposes: Hancock Brook Dam, Todd Hollow Road, Waterbury Road and the bed of the New York-New Haven Railroad; Northfield Brook Dam, Litchfield Street; Hop Brook Dam, Routes 63, 188, and Bristol Street; and Black Rock Dam, Route 109 and Northfield Street.

5. That, insofar as possible, deposition of sediment in streams be minimized and existing streamside vegetation be maintained within 50 feet of stream banks at all sites except within permanent pool areas.

6. That representatives of the Connecticut State Board of Fisheries and Game and this office be consulted at the time contract specifications are drawn up to consider the most feasible means of minimizing damages to fish and wildlife habitat as a result of construction operations.

7. That the taking of flowage easements by the construction agency be coordinated with the anticipated taking of public fishing and hunting easements by the State at the Hop Brook, Northfield

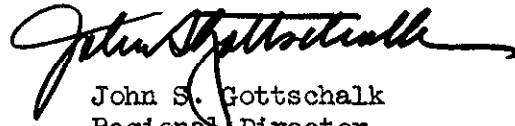
Brook, and Hancock Brook Reservoir sites.

8. That no commercial sand and gravel operations be permitted within lands acquired by the Federal Government at Hancock Brook Reservoir.

9. That additional detailed studies of fish and wildlife resources affected by the project be conducted as necessary during further planning and construction phases of the project to form the basis for such reasonable modifications for the conservation and development of fish and wildlife resources as may be desirable to obtain maximum overall project benefits.

10. That additional modifications to achieve maximum project benefits to be made in project facilities or operations, subsequent to completion of construction, as may be desirable to obtain maximum overall project benefits, on the basis of follow-up studies by this Bureau to improve or supplement measures taken for the conservation and development of fish and wildlife resources, notwithstanding Paragraph (g) Section 2 of the Fish and Wildlife Coordination Act.

Sincerely yours,



John S. Gottschalk
Regional Director

Attachment

STATE OF CONNECTICUT
BOARD OF FISHERIES AND GAME
2 Wethersfield Avenue
Hartford, Connecticut

C
O
P
Y

March 17, 1960

Mr. John S. Gottschalk
Regional Director
Fish and Wildlife Service
59 Temple Place
Boston, Mass.

Dear Mr. Gottschalk:

This Department has completed its review of the draft copies of the fish and wildlife reports pertaining to the Upper Naugatuck River Basin projects and the Hall Meadow Brook Reservoir project.

These reports, including their conclusion and recommendations, have my complete endorsement and we are willing to accept the responsibilities inherent in the execution of a General Plan.

Sincerely yours,

/s/ Lyle M. Thorpe
Director

AL/B



STATE OF CONNECTICUT

WATER RESOURCES COMMISSION

STATE OFFICE BUILDING • HARTFORD 15, CONNECTICUT

September 3, 1963

Mr. John Wm. Leslie, Chief
Engineering Division
U. S. Army Engineers
New England Division
424 Trapelo Road
Waltham 54, Massachusetts

Dear Mr. Leslie:

This will refer to your letter of August 14 concerning the plans of this Commission for setting stream encroachment lines below the proposed Black Rock Dam in the Naugatuck River basin.

The Commission had always planned to set the encroachment lines on the water way below Northfield Brook, Hancock Brook and Black Rock Dams simultaneously. These projects were included in this year's program, however, because of reduced funds they were dropped.

The Commission undoubtedly will include these in next year's program so that the necessary work in establishing these lines should be completed before or close to the time that the various construction projects are completed.

Very truly yours,

A handwritten signature in cursive script, reading "William S. Wise".

William S. Wise
Director

WSW:dlp

EXHIBIT NO. 3



STATE OF CONNECTICUT

WATER RESOURCES COMMISSION
STATE OFFICE BUILDING • HARTFORD 15, CONNECTICUT

April 24, 1964

John Wm. Leslie, Chief
Engineering Division
New England Corps of Engineers
424 Trapelo Road
Waltham 54, Massachusetts

Dear Mr. Leslie:

Re: Black Rock Reservoir
Water Supply Storage

Reference is made to your letter dated 14 February, 1964
File No. NEDED-D reiterating your request for our advice on whether
any communities or industries are interested in taking advantage of
possible water supply storage in the Black Rock Reservoir, Naugatuck
River.

Our knowledge of the activities in this area and comments from
the State Health Department indicate that there is presently no interest
in the addition of water supply storage in this flood control reservoir.

Very truly yours,

A handwritten signature in cursive script, reading "William S. Wise".

William S. Wise
Director

WSW/h

REGION ONE

CONNECTICUT
MAINE
MASSACHUSETTS
NEW HAMPSHIRE
NEW JERSEY
NEW YORK
RHODE ISLAND
VERMONT
PUERTO RICO

U. S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS

248 Farmington Avenue
Hartford 5, Connecticut

May 7, 1963

File: NEDGW

Brig. Gen. Seymour A. Potter
Division Engineer, Corps of Engineers
U. S. Engineer Division, New England
424 Trapelo Road
Waltham 54, Massachusetts

Attention: Mr. John Wm. Leslie
Chief, Engineering Division

Dear General Potter:

On April 26, 1963, Mr. Leslie, Chief, Engineering Division, Corps of Engineers, New England Division, wrote to this office requesting advice as to whether you could expect certification of the desirability and need for a bridge over the proposed Black Rock Dam on the Branch Brook in the Towns of Thomaston and Watertown, Connecticut.

The location of this dam, as shown on your enclosed reservoir map, has been discussed with the State Highway Department. Its effect on the State and Federal-aid highway systems has also been reviewed by both offices. As a result of this study and review, it has been determined that no public highway bridge is economically desirable or needed on this dam at this time and consequently, no certification may be expected.

The State's review of your plan has raised a question as to the spillway provided and its possible effect on the existing highway. It would be greatly appreciated if you would provide the State Highway Department a more detailed plan of the proposed spillway at this site at your earliest convenience. This will provide them an opportunity to make a further study of the situation resulting from the construction of this dam prior to actual design.

As the proposed dam affects a highway on the Federal-aid Secondary System which was built in 1945, we appreciate this opportunity to review the situation presented by your proposed construction.

Very truly yours,



Leo Grossman
Division Engineer

EXHIBIT NO. 5